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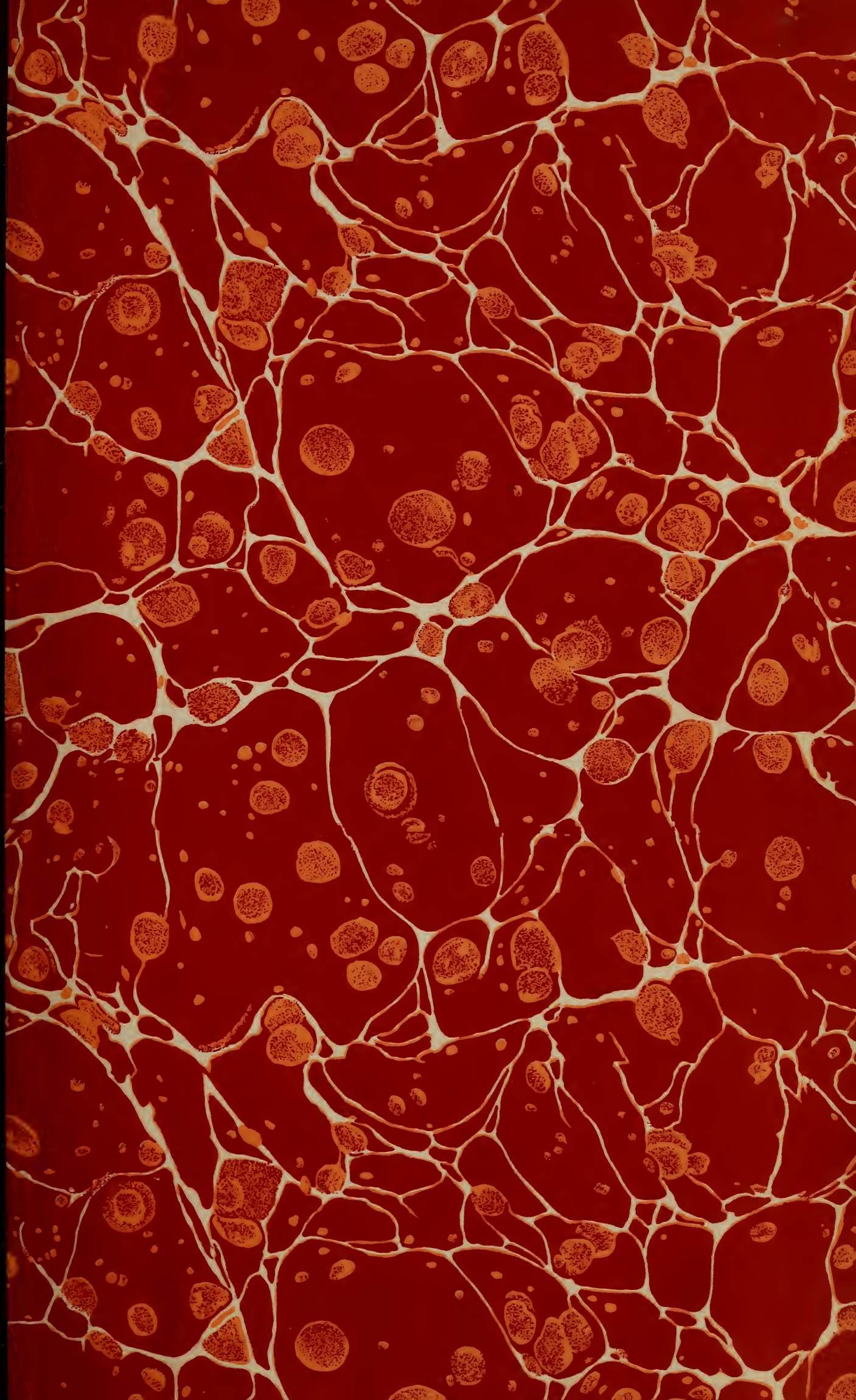
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PROGRAM OF WORK  
OF THE  
UNITED STATES  
DEPARTMENT OF AGRICULTURE  
FOR THE  
FISCAL YEAR 1919.

PREPARED UNDER THE DIRECTION OF THE  
SECRETARY OF AGRICULTURE

By E. H. BRADLEY.

JULY 1, 1918.



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## NOTE.

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This Program represents an attempt to forecast the work of the Department of Agriculture for an entire fiscal year. It is therefore necessarily somewhat tentative in character and subject to modification during the year.

The projects of each bureau and office upon which it is proposed to undertake work are briefly outlined, with an indication of the object, cooperative relationships, assignment or leadership, and proposed expenditures for the fiscal year.<sup>1</sup>

The department's activities are set forth under main groups, or principal lines of work, these being subdivided, where necessary or desirable, into projects covering specific phases of the work. The general arrangement follows as closely as possible the order of the appropriation items as they occur in the agricultural appropriation act.

In a broad way, the work of the department is divided into three types of activity—(1) research, or the scientific study of the fundamental problems of agriculture; (2) extension or educational work, or the dissemination of the information developed through the department's experiments and discoveries; and (3) regulation, or administration of various statutes with whose enforcement the department is charged. As far as practicable, the projects of each bureau have been segregated on the basis of this classification.

The chief purpose of the Program of Work is to inform workers within the Department of Agriculture of the projects under way in each bureau and office, and thus to facilitate correlation of work and coordination of effort and to reduce the possibility of useless or harmful duplication.

Copies of the Program are also furnished in limited numbers to each of the State agricultural colleges and experiment stations, with the view of informing those agencies regarding the scope of the department's activities in relation to work being prosecuted by the State institutions.

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<sup>1</sup> The fiscal year begins July 1. In making reference to fiscal years by dates the last half of the year is mentioned; for example, the year beginning July 1, 1918, is referred to as the "fiscal year 1919."





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# PROGRAM OF WORK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEAR 1919.

## OFFICE OF THE SECRETARY.

### SECRETARY'S OFFICE.

#### Secretary's Office:

*Object.*—The Secretary of Agriculture is charged with the work of promoting agriculture in its broadest sense. He exercises general supervision and control over the affairs of the department and formulates and establishes the general policies to be pursued by its various branches.

*Cooperation.*—Congress, other departments, the respective States, and the several branches of this department.

*Location.*—Washington, D. C.

*Date begun.*—Department was created in 1862; raised to the rank of an executive department in 1889.

*Assignment.*—David F. Houston, Secretary; Alonzo E. Taylor, Junius F. Cook, and Floyd R. Harrison, assistants to the Secretary; Harrison F. Fitts, private secretary.

*Proposed expenditures, 1918-19.*—\$38,100 (statutory \$29,000; miscellaneous expenses, \$4,000; details from bureaus, \$5,100).

(See also Supplement—Emergency Activities, p. 549.)

### OFFICES OF ASSISTANT SECRETARIES.

#### Offices of Assistant Secretaries:

*Object.*—The Assistant Secretaries of Agriculture assist in the general supervision of the work of the department and act for the Secretary in his absence.

*Cooperation.*—Other departments and all branches of this department.

*Location.*—Washington, D. C.

*Date begun.*—The first Assistant Secretary of Agriculture was appointed in 1889.

*Assignment.*—Clarence Ousley and G. I. Christie, Assistant Secretaries.

*Proposed expenditures, 1918-19.*—\$14,800 (statutory, \$12,770; miscellaneous expenses, \$2,100).

(See also Supplement—Emergency Activities, p. 549.)

### CHIEF CLERK'S OFFICE.

#### Chief Clerk's Office Proper:

*Object.*—The chief clerk has general supervision of clerks and employees, of the correspondence files and records of the Secretary's office, and of expenditures from appropriations for miscellaneous expenses, rent of buildings, etc. He is responsible for the enforcement of the general regulations of the department and is custodian of the buildings. This project includes work of the time clerk and provision for miscellaneous supplies and services for the department as a whole.

*Cooperation.*—Various branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1862.

*Assignment.*—R. M. Reese.

*Proposed expenditures, 1918-19.*—\$55,640 (statutory, \$21,800; extra labor, \$5,000; miscellaneous expenses, \$28,000; detail from States Relations Service, \$840).



**Supply Section:**

*Object.*—To make purchases of stationery and miscellaneous supplies for the Office of the Secretary and to sell the same to bureaus and independent offices at cost, securing reimbursement to the miscellaneous fund on vouchers stated to them for the amounts of such purchases; to repair, store, and keep in proper condition all lines of department property covered by letters of authorization from the Secretary; to receive and dispose of, by sale or otherwise, as recommended by the board of survey, all property turned in by the various bureaus and offices when of no further use to them; also to sell unused samples secured in the enforcement of various acts of Congress and such articles as come into existence as products of scientific investigations and experiments conducted by them.

*Cooperation.*—All branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—About 1883.

*Assignment.*—C. B. Lower.

*Proposed expenditures, 1918-19.*—\$22,640 (statutory, \$5,540; miscellaneous expenses, \$17,100).

**Mail and Files:**

*Object.*—To receive, record, and distribute mail for the Office of the Secretary and index, copy, file, and dispatch correspondence.

*Cooperation.*—Other branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1862.

*Results.*—Approximately 600,000 letters, papers, etc., were handled during the year.

*Assignment.*—Joseph Haley.

*Proposed expenditures, 1918-19.*—\$19,880 (statutory, \$16,280; miscellaneous expenses, \$600; details from bureaus, \$3,000).

**Telephones and Telegraph:**

*Object.*—Operation of the telephone system of the department and the transmission, receipt, and delivery of official telegrams.

*Cooperation.*—All branches of this department and local telegraph and telephone companies.

*Location.*—Washington, D. C.

*Date begun.*—1862.

*Assignment.*—George W. Connor.

*Proposed expenditures, 1918-19.*—\$5,420 (statutory, \$5,320; miscellaneous expenses, \$100.)

**Watch Force:**

*Object.*—To protect and watch 29 buildings occupied by the department, in three shifts, covering the entire 24 hours.

*Location.*—Washington, D. C.

*Date begun.*—1862.

*Assignment.*—F. C. More.

*Proposed expenditures, 1918-19.*—\$68,120 (statutory, \$57,400; extra labor, \$4,000; miscellaneous expenses, \$900; details from bureaus, \$5,820).

**Char and Labor Force:**

*Object.*—To clean and keep in sanitary condition the halls and toilets of the department buildings and to clean the rooms in the different units of the Office of the Secretary.

*Cooperation.*—Various branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1862.

*Assignment.*—F. C. More.

*Proposed expenditures, 1918-19.*—\$20,380 (statutory, \$17,520; miscellaneous expenses, \$100; details from bureaus, \$2,760).

**Stables:**

*Object.*—To feed, care for, and drive the horses, and care for the vehicles used by the Office of the Secretary and the Division of Publications.

*Location.*—Washington, D. C.

*Date begun.*—Many years ago.

*Assignment.*—R. M. Reese.

*Proposed expenditures, 1918-19.*—\$10,390 (statutory, \$6,840; miscellaneous expenses, \$3,550).



**Rent in the District of Columbia:**

*Object.*—To administer the appropriation for rent in the District of Columbia for the various branches of the department, 37 buildings and parts of buildings being under rental.

*Location.*—Washington, D. C.

*Date begun.*—Many years ago.

*Assignment.*—R. M. Reese.

*Proposed expenditures, 1918-19.*—\$184,498 (including \$14,559 from appropriation for general expenses, Bureau of Markets, and \$11,250 from appropriation for meat inspection, Bureau of Animal Industry).

**Total, Chief Clerk's Offices, \$386,968.**

(See also Supplement—Emergency Activities, p. 549.)

**SOLICITOR'S OFFICE.****Solicitor's Office:**

*Object.*—The Solicitor is charged by law (act of May 26, 1910) with the direction of the legal work of the department. Accordingly, he acts as legal adviser to the Secretary and the heads of the several branches of the department, conducts its legal work, and represents it in all legal matters. He approves, in advance of issue, all orders and regulations promulgated by the Secretary under statutory authority.

*Cooperation.*—All branches of the department, United States attorneys, etc.

*Location.*—Headquarters, Washington, D. C.; assistants to the Solicitor at Missoula, Mont., Portland, Oreg., Ogden, Utah, San Francisco, Cal., Denver, Colo., and Albuquerque, N. Mex.; title attorneys at various stations in North Carolina, South Carolina, Tennessee, West Virginia, New Hampshire, Virginia, Alabama, and Georgia.

*Date begun.*—1905 (General Order 85).

*Assignment.*—W. M. Williams.

*Proposed expenditures, 1918-19.*—\$183,290 (statutory, \$106,290; miscellaneous expenses, \$2,000; acquisition of lands, \$70,000; detail from Bureau of Markets, \$5,000).

(See also Supplement—Emergency Activities, p. 549.)

**DISBURSING OFFICE.****Disbursing Office:**

*Object.*—To keep appropriate ledgers relative to the advance and disbursement of all items of appropriations and to pay all accounts properly certified by the various branches of the department.

*Cooperation.*—All branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1862.

*Assignment.*—A. Zappone.

*Proposed expenditures, 1918-19.*—\$46,520 (statutory, \$44,920; miscellaneous expenses, \$1,600).

(See also Supplement—Emergency Activities, p. 549.)

**OFFICE OF INSPECTION.****Office of Inspection:**

*Object.*—To act as the clearing house of the Secretary's office in fiscal transactions between the bureaus and claimants and otherwise assist in the fiscal operations of the bureaus; to handle fiscal correspondence between the Secretary's office and the Treasury Department and personnel inspection matters; and to prepare certain annual and other reports.

*Cooperation.*—All branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Assignment.*—Alex. McC. Ashley.

*Proposed expenditures, 1918-19.*—\$23,000 (statutory, \$18,000; miscellaneous expenses, \$700; details from bureaus, \$4,300).

(See also Supplement—Emergency Activities, p. 549.)

**APPOINTMENT CLERK'S OFFICE.****Appointment Clerk's Office:**

*Object.*—To prepare all papers relating to appointments, transfers, promotions, reductions, details, furloughs, removals, and other changes in the personnel of the department; to compile and furnish to the Secretary data needed to insure uniformity of action in the changes in the personnel in the various branches of the department; to maintain and keep current a separate record of the service of each employee in the department in the past or at present; to compile and forward to the United States Civil Service Commission a monthly statement of all changes in the personnel of the department; to conduct all correspondence necessary with the Civil Service Commission relative to changes made or proposed to be made in the personnel of the department, including requests for certifications and reports on certificates and requests for special examinations; to maintain records and from these records to compile and furnish statistics to the Secretary pertaining to changes in the personnel.

*Cooperation.*—All branches of the department and Civil Service Commission.

*Location.*—Washington, D. C.

*Date begun.*—1891.

*Assignment.*—P. L. Gladmon.

*Proposed expenditures, 1918-19.*—\$19,690 (statutory, \$12,000; miscellaneous expenses, \$800; details from bureaus, \$6,890).

**MECHANICAL SUPERINTENDENT'S OFFICE.****Mechanical Shops:**

*Object.*—Maintenance of mechanical shops for the repair and upkeep of the buildings, laboratories, and equipment, including electrical, carpenter, and cabinet work, plumbing, painting, rubber-stamp making, and operation of elevators.

*Cooperation.*—Various branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1909.

*Assignment.*—Roy L. Swenson.

*Proposed expenditures, 1918-19.*—\$125,760 (statutory, \$88,980; extra labor, \$3,000; miscellaneous expenses, \$30,000; details from bureaus, \$3,780).

**Power Plant:**

*Object.*—Supervision of engineers and firemen, except those of the Weather Bureau, and provision of heat, light, power, and electricity for all buildings of the department in Washington, except those occupied by the Weather Bureau, Forest Service, and Bureau of Public Roads.

*Cooperation.*—Various branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1908.

*Assignment.*—Roy L. Swenson.

*Proposed expenditures, 1918-19.*—\$63,760 (statutory, \$15,760; miscellaneous expenses, \$48,000).

**Total, Mechanical Superintendent's Office, \$189,520.**

**LIBRARY.****Library:**

*Object.*—To assist the workers in the department, the State agricultural colleges and experiment stations, and the public in general by making available the literature of agriculture and the related sciences and by supplying bibliographical information in regard to these subjects. The library is charged with the purchase of all books and periodicals for the use of the department in Washington and supervises their arrangement, cataloguing, and use; prepares bibliographies and lists on subjects connected with the work of the department; supervises, in general, the distribution of department publications to libraries; has charge of the foreign mailing lists for department publications and arranges exchanges.



*Cooperation.*—All branches of the department, the Food Administration, the Library of Congress, and other libraries and institutions in and outside of Washington, D. C.

*Location.*—Washington, D. C.

*Date begun.*—1862.

*Results.*—The library has been enriched by approximately 9,000 accessions during the fiscal year ended June 30, 1918, not including current numbers of periodicals. Approximately 2,300 periodicals were received currently. The circulation of books and periodicals was approximately 170,000. There were added to the catalogue during the year over 20,000 cards. The dictionary catalogue of the library now contains more than 400,000 cards, constituting an invaluable guide to the literature of agriculture and the related sciences.

*Assignment.*—Claribel R. Barnett, Emma B. Hawks.

*Proposed expenditures, 1918-19.*—\$50,160 (statutory, \$32,160; general expenses, \$18,000).

## OFFICE OF EXHIBITS.

### Office of Exhibits:

*Object.*—To handle the work of the department in connection with exhibits at fairs and expositions of various kinds; cooperate with the various branches of the department in preparing exposition material; ship, install, display, and care for exhibits; and investigate methods of displaying them.

*Cooperation.*—All bureaus and offices of the Department of Agriculture and other executive departments and independent Government establishments; State colleges and experiment stations and fairs, expositions, and show organizations of various kinds throughout the United States.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—During the past fiscal year, the office has handled agricultural exhibits at the following large expositions: Industrial Exposition and Fair, Cleveland, Ohio; Kansas State Fair, Hutchinson, Kans.; International Wheat Show, Wichita, Kans.; State Fair of Texas, Dallas, Tex.; International Farm and Live-Stock Exposition, New Orleans, La.; Florida State Fair and Exposition, Jacksonville, Fla.; Patriotic Food Show, Chicago, Ill.; Patriotic Show "Over There," Baltimore, Md.; National Milk and Dairy Farm Exposition, New York, N. Y.; and numerous minor fairs and expositions, displays, etc. Plans are being formulated, in cooperation with other executive departments, to participate at a number of the larger State fairs and expositions to be held throughout the United States during the fall and winter months of 1918-19. This office has handled all matters relative to expositions and exhibits and acted as a center for information upon the subject.

*Assignment.*—F. Lamson-Scribner.

*Proposed expenditures, 1918-19.*—\$6,510 (statutory, \$6,260; miscellaneous expenses, \$250).

(See also Supplement—Emergency Activities, p. 550.)

## OFFICE OF FOREST APPEALS.

### Office of Forest Appeals:

*Object.*—Created for the purpose of having, under the immediate supervision of the Secretary, an officer independent of the Forest Service, by whom appeals from the decision of that bureau affecting land claims and land-classification matters might be passed upon, after a careful examination of the record and a consideration of the questions involved, in order that the Secretary might thus be assisted in reaching a final decision. At the direction of the Secretary the office also cooperates with the Office of Inspection in the investigation of personnel cases involving discipline, demotion, or dismissal, and complaints by or against bureau or department officers.

*Cooperation.*—Forest Service, in appeal cases; Office of Inspection, in connection with personnel cases.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—During the past year the following matters have been considered and recommendations made thereon for action by the Secretary: 48 cases on appeal, 6 petitions for review of Secretary's decisions, 1 motion to allow appeal, 1 complaint, and 2 personnel cases.

*Assignment.*—Thos. G. Shearman.

*Proposed expenditures, 1918-19.*—\$5,550 (statutory, \$1,200; miscellaneous expenses, \$100; detail from Forest Service, \$4,250).

## PUBLICATION WORK.

### Supervision:

*Object.*—General direction and supervision of the publication activities of the department and the expenditures of all funds appropriated for printing.

*Cooperation.*—All branches of this department, and Government Printing Office.

*Location.*—Washington, D. C.

*Date begun.*—Present organization, 1917; for specific phases of the work, see projects which follow.

*Assignment.*—Clarence Ousley, Assistant Secretary; Edwy B. Reid, chief, Division of Publications, and assistant in administration of all publication and motion-picture activities.

*Proposed expenditures, 1918-19.*—\$16,160 (Division of Publications—statutory, \$14,660; general expenses, \$1,500).

### Editorial Work:

*Object.*—To criticize constructively all manuscripts submitted for publication by the department; to edit and approve the same for printing; to revise and correct all proofs; and to supervise all the printing work of the department.

*Cooperation.*—All branches of the department and the Government Printing Office.

*Location.*—Washington, D. C.

*Date begun.*—1890.

*Assignment.*—B. D. Stallings, William F. Harding, Robert B. Handy, Frank H. Valentine.

*Proposed expenditures, 1918-19.*—\$23,765 (Office of the Secretary—salaries, \$7,680; miscellaneous expenses, \$200; Division of Publications—statutory, \$11,160; general expenses, \$325; details from the Bureau of Markets, \$4,400.)

### Indexing:

*Object.*—To prepare indexes to publications and card-index, by subjects, all publications issued by the department; and to prepare replies to requests for references to department publications.

*Cooperation.*—All branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—C. H. Greathouse.

*Proposed expenditures, 1918-19.*—\$10,735 (Division of Publications—statutory, \$10,500; general expenses, \$235).

### Illustrations:

*Object.*—To prepare drawings and photographs for use in illustrating publications, for official records, and for lectures; and to make lantern slides for official use and for sale to outside applicants.

*Cooperation.*—All branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1894.

*Assignment.*—A. B. Boettcher, J. H. Stevenson.

*Proposed expenditures, 1918-19.*—\$35,360 (Division of Publications—statutory, \$26,660; general expenses, \$8,700).



**Office of Information:**

*Object.*—To secure the widest possible circulation for the discoveries and recommendations of the scientists, specialists, and field workers of the department and for agricultural advice, warnings, and information as to regulatory matters by supplying the public press with facts taken from publications and also from authoritative statements of specialists, in a form to attract attention and lead to the adoption of the methods recommended. This office also issues a Weekly News Letter containing seasonal and other information in popular form.

*Cooperation.*—All branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Assignment.*—Harlan D. Smith.

*Proposed expenditures, 1918-19.*—\$20,960 (Office of the Secretary—salaries, \$18,560; miscellaneous expenses, \$2,400).

(See also Supplement—Emergency Activities, p. 549.)

**Distribution of Documents:**

*Object.*—To distribute department publications; to duplicate and distribute circulars of information; to maintain special and general mailing lists; and to receive, comply with, and reply to miscellaneous applications for department publications.

*Cooperation.*—All branches of this department, and Government Printing Office.

*Location.*—Washington, D. C.

*Date begun.*—1896.

*Assignment.*—F. J. P. Cleary.

*Proposed expenditures, 1918-19.*—\$125,750 (Division of Publications—statutory, \$111,040; general expenses, \$14,710).

(See also Supplement—Emergency Activities, p. 549.)

**Motion-Picture Work:**

*Object.*—To secure the widest possible circulation, by means of motion pictures and correlated material, of information concerning the broad features of the work of the department and the more important results of its investigations.

*Cooperation.*—All branches of this department; also the Department of the Interior, State colleges and experiment stations, motion-picture corporations, fairs, expositions, associations, and other private institutions.

*Location.*—Washington, D. C.

*Assignment.*—Don Carlos Ellis.

*Proposed expenditures, 1918-19.*—\$15,250 (Division of Publications—statutory, \$4,900; general expenses, \$10,350).

**Total, Publication Work, \$247,980.** In addition, \$600,000 is appropriated under the sundry-civil act as a general printing fund for the department.

(See also Supplement—Emergency Activities, p. 549.)

## OFFICE OF FARM MANAGEMENT.

### GENERAL ADMINISTRATION.

#### Office of Chief:

*Object.*—To supervise the investigations relating to farm management and farm practice.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—R. L. Adams, acting chief; E. H. Thomson, assistant chief.

*Proposed expenditures, 1918-19.*—\$6,400.

#### Office of Assistant to the Chief:

*Object.*—General supervision of the fiscal affairs of the office and of the clerical force and janitor service; the handling of mails; operation and maintenance of central file and property room, photographic laboratory, and library; all matters pertaining to appointments, pay rolls, and leaves of absence.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—Lisle Morrison.

*Proposed expenditures, 1918-19.*—\$26,100.

#### Editorial Work:

*Object.*—To edit and prepare for printing manuscripts and to read and revise proofs of articles submitted for publication by members of the office; also similar work in connection with miscellaneous printing required by the office.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Assignment.*—Raymond Evans.

*Proposed expenditures, 1918-19.*—\$6,350.

**Total, General Administration, \$38,850, including \$34,330 statutory.**

[Research.]

## INVESTIGATIONS IN FARM ECONOMICS AND FARM PRACTICE.

### CROP ENTERPRISES.

#### Farm Practice in the Production of Sugar Beets:

*Object.*—To investigate farm practices in the production of sugar beets with reference to the labor and equipment required for the various operations in the production of this crop, the relation of this labor and equipment to that required in other enterprises on the farm, the proper balance between sugar-beet production and other farm enterprises, the most desirable acreage of sugar beets under given conditions, and the conditions which render this crop a profitable part of the farm business.

*Procedure.*—Studies are made in each of the sugar-beet areas to obtain data on the character and relative magnitude of the crops grown on sugar-beet farms and the details of farm practice, especially those methods which have given the best results. The information thus obtained is compiled with a view to determine the proper place that sugar beets should occupy in a particular region and the relation of the various farm practices to efficiency in the conduct of the farm business.

*Cooperation.*—Office of Sugar-Plant Investigations, Bureau of Plant Industry; and farmers in various parts of the country.

*Location.*—Important sugar-beet producing districts in Michigan, Ohio, Colorado, Utah, Idaho, Montana, and California.

*Date begun.*—1910.



*Results.*—Nearly 2,000 records have been obtained in the various sugar-beet areas. These records have been summarized and the results prepared for publication. Special attention has been given to the practices followed by the best sugar-beet growers and the effect of these practices upon yields and the efficiency of the operations connected with the crop. The following manuscripts have been submitted for publication as Department Bulletins: "Farm Practice in Growing Sugar Beets in Three Districts in Utah and Idaho, 1914-15;" "Farm Practice in Growing Sugar Beets in Four Districts in Michigan and Ohio, 1914-15;" "Farm Practice in Growing Sugar Beets in Three California Districts, 1915-16;" and "Farm Practice in Growing Sugar Beets in Three Districts in Colorado, 1914-15."

*Assignment.*—L. A. Moorhouse, T. H. Summers, R. S. Washburn.

*Proposed expenditures, 1918-19.*—\$8,400.

### **Farm Practice in the Production of Hay and Grasses:**

*Object.*—To investigate farm practice in the production of hay and grasses with reference to the labor and equipment required for the various operations, the most efficient crews used in making hay, and the relation of this labor and equipment to that required in other enterprises on the farm.

*Procedure.*—Detailed studies are conducted on a number of farms in regions where the hay crop is of primary importance. The data obtained are analyzed to determine the best farm practices and the most efficient methods found in various regions, the results of which are made available through publications.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Important hay-producing districts in the various States.

*Date begun.*—1910.

*Results.*—Very extensive data have been obtained on the methods of handling hay in various parts of the country. Special attention has been given to the efficiency of different sized crews with a view to save labor through a full utilization of teams and machinery. The following publications have been issued: Office of the Secretary Circular 67, "Measuring Hay in Ricks or Stacks"; Department Bulletins—578, "A Study of Haymaking Crews and Labor Costs," and 641, "Farm Practice in the Production of Hay in Steuben County, N. Y., and Washington County, Pa."; and Farmers' Bulletins—677, "Growing Hay in the South for Market"; 838, "Harvesting Hay with the Sweep Rake"; 943, "Haymaking"; 956, "Curing Hay on Trucks"; and 977, "Hay Caps."

*Assignment.*—H. B. McClure.

*Proposed expenditures, 1918-19.*—\$6,320.

### **Farm Practice in the Production of Potatoes:**

*Object.*—To investigate farm practice in the production of Irish potatoes, the equipment required, amount of labor needed for the various operations, time of the various operations, and the relation of the potato crop to the other crops on the farm; also to study the conditions which render the potato crop a desirable part of the farm business and the systems of management under which it can be grown with the greatest efficiency.

*Procedure.*—Investigations are made on a large number of farms in all the important potato-growing districts. The results of these field investigations, involving records as to each detail of the crop and the experiences of potato growers, are compiled and summarized to determine the improved practices which give the best results and the economic factors governing the production of the crop in various regions.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Important potato-producing districts in 19 States, extending from Maine to California.

*Date begun.*—1912.

*Results.*—A large number of records have been collected and compiled dealing with farm practices in growing potatoes in each of the important producing districts. Investigations have been conducted for a number of years and the data are being compiled for publication.

*Assignment.*—E. H. Thomson, H. H. Clark.

*Proposed expenditures, 1918-19.*—\$600.



**Farm Practice in the Production of Cotton:**

*Object.*—To investigate the most improved farm practices as worked out from the experience of farmers in the production of cotton, the equipment necessary, amount of labor for each of the various operations, and the relation that the cotton crop should bear to the other enterprises on the farm.

*Proceedure.*—Field investigations are conducted in all the regions where cotton growing is of primary importance. Records from these field studies and the experiences of the best growers are compiled and put in summary form so as to be available for publication.

*Location.*—Important cotton-producing districts in the Southern States.

*Date begun.*—1913.

*Results.*—Extensive investigations have been made in all the important cotton-growing areas. The results of these studies have been compiled and are being made ready for publication. The investigations under this project have contributed to the preparation of the bulletins listed under "Farm Organization in the Cotton Belt."

*Assignment.*—A. G. Smith, E. S. Haskell, M. A. Crosby.

*Proposed expenditures, 1918-19.*—\$500.

**Farm Practice in the Production of Corn Silage:**

*Object.*—To investigate the best farm practices followed in the production of corn silage, the equipment required, amount of labor for each of the various operations, and the methods which have given the greatest efficiency in handling this material; also to make studies regarding the capacity of silos and shrinkage of silage.

*Procedure.*—Field studies are made in districts where corn silage is an important crop. Tests and weighings of silage are carried out in cooperation with farmers. These studies will be continued for a number of years so as to give reliable data for varying conditions in different parts of the country.

*Cooperation.*—New York, Wisconsin, and Minnesota agricultural experiment stations.

*Location.*—Important districts in the Northern States where corn silage is produced.

*Date begun.*—1906.

*Results.*—A large amount of data has been collected from farmers with reference to the most improved practices used in the production of corn silage and the amount of labor and equipment required. Data on weights and shrinkages of silage have also been collected on several hundred farms, and this information is now being compiled and made ready for publication.

*Assignment.*—H. G. Strait, M. R. Cooper, J. S. Ball.

*Proposed expenditures, 1918-19.*—\$7,700.

**Farm Practice in the Production of Fruits:**

*Object.*—To investigate orchard practices in the production of fruits, the equipment necessary for various operations, and the relation that the fruit enterprise bears to the other parts of the farm business; also to investigate the planting and growing of young orchards and the orchard practices which have been found to be most efficient under varying conditions.

*Procedure.*—Field studies are made in each of the districts where fruit growing is of primary importance. The results from these investigations and the experience of the best growers are compiled for publication.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Important fruit-growing districts in Washington, Oregon, California, Idaho, Colorado, Missouri, New York, Virginia, West Virginia, and the New England States.

*Date begun.*—1912.

*Results.*—Over 1,500 records have been made on farms where orchards are an important part of the business. These data deal with the various orchard practices, the time required to perform each operation, and the experiences of the growers as to the best methods to follow. The following publications have been issued: Department Bulletins—130, "Operating Costs of a Well Established New York Apple Orchard"; 446, "Costs of Producing Apples in Wenatchee Valley, Wash."; 500, "Cost of



Producing Apples in Western Colorado"; 518, "Cost of Producing Apples in Hood River Valley"; 636, "Cost of Producing Apples in Payette County, Idaho"; and 614, "Cost of Producing Apples in Yakima Valley, Wash."

*Assignment.*—G. H. Miller.

*Proposed expenditures, 1918-19.*—\$8,450.

**(Economics of the Farm Wood Lot:** The results of this work are being compiled for publication.)

### **Farm Practice in the Management of Pastures and Ranches:**

*Object.*—To ascertain the most efficient farm practices used in the maintenance and building up of farm pastures and grazing areas; to determine the extent that the pasture area should bear to the other crop areas on the farm as determined by the systems of farming followed in each region; and to develop systems of pasture management.

*Procedure.*—Field investigations are conducted in important pasture areas with a view to ascertain the most improved farm practices as developed by farmers in each district. These practices are analyzed in detail and the results made available in publications.

*Cooperation.*—States Relations Service and other bureaus of this department, and State experiment stations.

*Location.*—Washington, D. C., and various areas throughout the country.

*Date begun.*—1908.

*Results.*—Only preliminary studies have been made on this problem, attention having been given almost entirely to farm practices on tillable areas.

*Assignment.*—E. O. Wooton.

*Proposed expenditures, 1918-19.*—\$7,720.

**Total, Crop Enterprises, \$39,690, including \$8,940 statutory.**

### **LIVE-STOCK ENTERPRISES.**

#### **Farm Practice in Producing Feeder Cattle:**

*Object.*—To determine the conditions under which the rearing of beef animals is a desirable farm enterprise, the proper magnitude of the enterprise under given conditions, character of equipment required, amount of labor involved, and seasonal distribution of this labor; and to determine the relation of methods of feeding and herd management to efficiency in production.

*Procedure.*—Detailed records of farm practice are obtained from farms and ranches where the raising of feeder cattle is an important enterprise. A study is made of the different methods of herd management in common practice and of the experience of the most successful feeders.

*Cooperation.*—Bureau of Animal Industry.

*Location.*—Middle Western States.

*Date begun.*—1914.

*Results.*—Over 1,000 records have been obtained from farmers in the Central West for four consecutive years showing the methods used and the items of feed and labor necessary in raising feeder cattle. These records have been compiled and include data on maintaining breeding herds and raising calves. Some of the results of the work under this project are published in Department Bulletin 615, "Economical Winter Feeding of Beef Cows in the Corn Belt."

*Assignment.*—J. S. Cotton, J. Whitson.

*Proposed expenditures 1918-19.*—\$3,520.

#### **Farm Practice in Finishing Beef Cattle:**

*Object.*—To determine the best methods of fattening beef cattle and the relation that this enterprise bears to the conduct of the whole farm business.

*Procedure.*—Same as preceding project.

*Cooperation.*—Bureau of Animal Industry.

*Location.*—Middle Western States.

*Date begun.*—1914.

*Results.*—Data on these investigations are being compiled for publication.

*Assignment.*—J. S. Cotton, J. Whitson.

*Proposed expenditures, 1918-19.*—\$3,520.

**Farm Practice in the Production of Baby Beef:**

*Object.*—To determine the conditions under which the production of baby beef on farms and ranches is economical for the different sections of the country; to investigate the methods used by various farmers and the amount of feed and labor necessary in maintaining breeding herds and raising calves.

*Procedure.*—Same as preceding project.

*Cooperation.*—Bureau of Animal Industry.

*Location.*—Middle Western States.

*Date begun.*—1914.

*Results.*—A preliminary report on the production of baby beef on farms in the Central West is contained in Report 111, Office of the Secretary.

*Assignment.*—J. S. Cotton, J. Whitson.

*Proposed expenditures, 1918-19.*—\$3,520.

**Farm Practice in the Maintenance of Farm Work Horses and the Raising of Colts:**

*Object.*—To investigate the practices which obtain in different sections of the country and under various conditions with reference to the maintenance of farm work horses, with a view to determine those which prove to be the most satisfactory from the standpoint of working efficiency and cost to the farmer; also to determine the practicability of raising colts as a part of the farm business and the relation of such an enterprise to the cost of horse labor.

*Procedure.*—Field investigations have been made for a number of years in different areas. These studies include data on the raising of colts on the farms where the observations were made. Extensive information has also been compiled on the hours of work performed by work horses on farms of different types and systems of management and on the relation of the hours of work to the cost per hour of labor.

*Cooperation.*—New York, Wisconsin, and Minnesota experiment stations

*Location.*—Middle Western States.

*Date begun.*—1906.

*Results.*—Preliminary results on the maintenance of work horses and the raising of colts have been published in Department Bulletin 560, "Cost of Keeping Farm Horses and Cost of Horse Labor."

*Assignment.*—M. R. Cooper.

*Proposed expenditures, 1918-19.*—\$900.

**Farm Practice in the Production of Dairy Cattle:**

*Object.*—To determine the economic conditions under which the raising of dairy calves is desirable on farms in different regions and the relation that this enterprise should bear to the rest of the farm business.

*Procedure.*—These investigations have been carried on in connection with cost-accounting studies on farms in various regions where the raising of dairy calves is an important farm enterprise.

*Cooperation.*—New York, Wisconsin, and Minnesota experiment stations.

*Location.*—New York, Wisconsin, and Minnesota.

*Date begun.*—1906.

*Results.*—Extensive records have been obtained for a period of years from a number of farmers on farm practices with reference to the raising of dairy cattle. Department Bulletin 49, "The Cost of Raising a Dairy Cow," has been issued.

*Assignment.*—J. S. Ball, H. G. Strait.

*Proposed expenditures, 1918-19.*—\$2,250.

**Economics of Dairy Farming:**

*Object.*—To investigate the distribution of the various phases of dairy farming and the causes underlying this distribution; the labor requirements of the dairy enterprise and the relation of this labor to other labor on the farm; the proper status of dairying in the farm business; cropping systems on dairy farms; the status of pasture on dairy farms; dairy-farm equipment; and the relation of dairying to other farm enterprises.

*Procedure.*—These investigations are conducted by making field investigations on a large number of dairy farms operating under different conditions and determining the cropping systems, methods of labor management, and other improved practices which have been found desirable.



*Location.*—Northeastern States.

*Date begun.*—1906.

*Results.*—A large amount of data has been obtained from dairy farmers for a period of years, these records dealing with the items of labor and equipment leading to the production of milk, the best cropping systems followed to give the maximum returns from the dairy enterprise, and the analysis of those economic factors which make dairying desirable as a part of the farm business. Results are published in Department Bulletin 501, "A Study of the Cost of Producing Milk on Four Dairy Farms."

*Assignment.*—E. H. Thomson.

*Proposed expenditures, 1918-19.*—\$2,250.

**Total, Live-Stock Enterprises, \$15,960, including \$3,300 statutory.**

#### TENURE INVESTIGATIONS.

##### Tenure Investigations:

*Object.*—To determine the prevailing systems of farm tenantry and the underlying principles of tenant farming; to devise lease contracts that will secure an equitable division of the farm income and which will tend to maintain a system of farming that will not prove detrimental to the local development of agriculture.

*Procedure.*—Complete financial analyses of a large number of tenant farms in specific areas are made. These individual farm analyses are summarized to determine what the tenant and landlord receive for their investment and their year's work.

*Cooperation.*—States Relations Service and various State colleges and experiment stations.

*Location.*—Washington, D. C., and various areas in the several States.

*Date begun.*—1906.

*Results.*—Studies have been made of the systems of renting farms as found in all the important agricultural regions. These data have been analyzed with respect to the underlying principles of these contracts and the effect the various systems of tenantry have upon the income received by tenant and landlord. The best systems of rental have been studied in detail and the results published. Department Bulletins—337, "A Study of a Tenant System of Farming in the Yazoo-Mississippi Valley"; 411, "Systems of Renting Truck Farms in Southwestern New Jersey"; 603, "A Study of Share Rented Dairy Farms in Green County, Wis., and Kane County, Ill.," and 650, "Lease Contracts Used in Renting Farms on Shares," have been issued.

*Assignment.*—E. V. Wilcox, E. A. Boeger, H. A. Turner.

*Proposed expenditures, 1918-19.*—\$12,575, including \$900 statutory.

**Total, Investigations in Farm Economics and Farm Practice, \$68,225, including \$13,140 statutory.**

[Research.]

#### INVESTIGATIONS IN FARM ORGANIZATION.

##### FARM-MANAGEMENT SURVEYS.

##### Analysis of the Farm Business:

*Object.*—To analyze the farm business from the standpoint of investment, receipts, expenditures, and net income, in order to determine the important factors which largely affect this income. These investigations include studies of the relation of systems of management to profits, size of business, and the diversity and efficiency of the various farm crops and classes of live stock as related to the business as a whole.

*Procedure.*—Complete financial analyses are made of a large number of farms in specific areas. These individual farm analyses are summarized and classified in various ways to determine what each farmer receives for his year's work and to learn the effect that such factors as yield of crops, use of labor and machinery, and general efficiency of the farm business have upon profits.

*Cooperation.*—States Relations Service and various State colleges and experiment stations.

*Location.*—Washington, D. C., and selected areas in the various States.

*Date begun.*—1906.

*Results.*—Business analyses have been made of several thousand farms in the various areas involved. Through these analyses it has been possible to determine many of the factors which underlie the cause of success or failure in farming and to give a much clearer understanding of the problems of farm organization and the relative influence on the farmer's income of crop yield, efficiency of live stock, and the use of labor and machinery. The following publications have been issued: Department Bulletins—117, "Profits in Farming on Irrigated Areas in Utah Lake Valley"; 341, "Farm Management Practice in Chester County, Pa."; 492, "An Economic Study of Farming in Sumter County, Ga."; and 633, "Factors of Successful Farming Near Monett, Mo."

*Assignment.*—H. M. Dixon, H. W. Hawthorne, E. D. Strait, Frank Montgomery.

*Proposed expenditures, 1918-19.*—\$46,220.

### **Contribution of the Farm Toward the Farmer's Living:**

*Object.*—To determine what the farm contributes directly toward the family living in the form of garden products, milk, butter, eggs, etc.; to find the relation and value of these products to the farmer's income and to the welfare of the farm family.

*Procedure.*—Complete records giving the amount and value of the items constituting the important features of the farmer's living are obtained from several hundred farmers in specified areas. These individual records are summarized and classified to bring out the factors desired.

*Location.*—Washington, D. C., and selected areas in the various States.

*Date begun.*—1914.

*Results.*—Much valuable information has been collected relative to the direct income the farmer receives in the form of garden products, milk, butter, eggs, etc. The following publications have been issued: Department Bulletins—410, "Value to Farm Families of Food, Fuel, and Use of House," and 602, "Value of a Small Plat of Ground to the Laboring Man"; and Farmers' Bulletin 635, "What the Farm Contributes Directly Toward the Farmer's Living."

*Assignment.*—W. C. Funk.

*Proposed expenditures, 1918-19.*—\$1,200.

**Total, Farm-Management Surveys, \$47,420, including \$12,300 statutory.**

### **FARM EQUIPMENT.**

#### **Farm Equipment:**

*Object.*—Determination of the character, cost, and adequacy of equipment in machinery, implements, work horses, etc., and study of methods of operation and efficiency on farms of different types and sizes in different sections of the country.

*Procedure.*—Data are collected dealing with the farmer's experience in regard to the various items of farm equipment. These field results are compiled and reports prepared dealing with the cost, character, and use of the various types with reference to the profitable operation of the farm.

*Cooperation.*—Bureau of Public Roads.

*Location.*—General.

*Date begun.*—1906.

*Results.*—(1) Five bulletins dealing with economic features of farm equipment were issued during the past year, as follows: Department Bulletins—627, "Cost of Harvesting Wheat by Different Methods," and 423, "Labor Requirements of Dairy Farms as Influenced by Milking Machines"; and Farmers' Bulletins—816, "Minor Articles of Farm Equipment"; 838, "Harvesting Hay with the Sweep-Rake"; and 904, "Fire Prevention and Fire Fighting on the Farm." Several other manuscripts on subjects relating to farm equipment have been submitted for publication. Studies of small farm tools and handy devices, also certain investigations with reference to the harvesting of wheat, have been undertaken. The study of the economic value of farm tractors in various types of farming in different sections of the country have been continued.



(2) Prior to the past year the work in farm-equipment investigations followed the same lines as above outlined, and some of the results are contained in the following publications: Bureau of Plant Industry Bulletins—170, "Tractor Plowing," and 212, "Study of Farm Equipment in Ohio"; B. P. I. Circular 44, "Minor Articles of Farm Equipment"; Department Bulletins—3, "A Normal Day's Work for Various Farm Operations"; 174, "Farm Experience with the Tractor"; 321, "Cost of Fencing Farms in the North-Central States"; and 338, "Machinery Costs of Farm Operations in Western New York"; and Farmers' Bulletin 719, "An Economic Study of the Tractor in the Corn Belt."

*Assignment.*—A. P. Yerkes, H. R. Tolley, L. A. Reynoldson, Lillian M. Church.

*Proposed expenditures, 1918-19.*—\$16,360, including \$2,300 statutory.

#### APPLICATION OF FARM ECONOMICS TO FARM PRACTICE.

##### Farm Organization in the Northeastern and Northern Dairy Region:

*Object.*—To interpret the economic conditions prevailing in this agricultural region and to correlate data collected by the various agencies of the department, the State institutions, and others and utilize such data to develop systems of farm organization and operation adapted to the various types and sizes of farms prevailing, or that should prevail, in this section; and to work out cropping systems and rotations that are particularly suited to eastern dairy farms, especially systems of farming which can be operated with a minimum expenditure for concentrated feeds.

*Procedure.*—The analytical studies of the farm business made by the various departmental agencies and by the State colleges of agriculture are interpreted and applied in the development of systems of farming suited to this particular area. Investigations are also made of a number of dairy farms in regions where satisfactory cropping systems have been partly worked out by the farmers themselves. The best features of each of these systems are analyzed and described in bulletin form.

*Cooperation.*—States Relations Service, the various State colleges and experiment stations, and individual farmers.

*Location.*—Washington, D. C., and the northeastern section of the United States.

*Date begun.*—1913.

*Results.*—Substantial progress has been made in analyzing farm-management problems, particularly in the New England States, by means of over 1,500 records showing the receipts, expenditures, and net income received as a result of different systems of management and types of farming, these data being used to develop profitable systems of farm organization in the Northeastern States. Farmers' Bulletin 929, "The Place of Sheep on New England Farms," has been published.

Valuable results have been obtained on a number of farms where large dairy herds are maintained through a minimum expenditure for feeds by reason of efficient cropping systems with respect to corn silage and leguminous hay. A description of the practices which have proved successful has been prepared for publication.

*Assignment.*—F. H. Branch, G. A. Billings, H. H. Mowry.

*Proposed expenditures, 1918-19.*—\$9,290.

##### Farm Organization in the Middle-Atlantic and Appalachian-Mountain Region:

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Cooperation.*—Same as preceding project.

*Location.*—Washington, D. C., and the Middle-Atlantic and Appalachian-Mountain region.

*Date begun.*—1913.

*Results.*—Substantial progress has been made in developing systems of farming, rotations, and improved farm practices in this area. The following publications have been issued: Department Bulletins—29, "Crew Work, Costs, and Returns in Commercial Orchardling in West Virginia"; 482, "Farming in the Bluegrass Region"; 548, "The Business of Ten



Dairy Farms in the Bluegrass Region of Kentucky"; and 678, "Influence of a City on Farming"; Farmers' Bulletins—432, "How a City Family Managed a Farm"; 546, "How to Manage a Corn Crop in Kentucky and West Virginia"; 812, "How Live Stock Is Handled in the Bluegrass Region of Kentucky"; and 924, "A Simple Way to Increase Crop Yields." A bulletin entitled "An Agricultural Survey of Brooks County, W. Va," has been published in cooperation with the West Virginia Experiment Station.

*Assignment.*—H. A. Miller.

*Proposed expenditures, 1918-19.*—\$6,320.

### **Farm Organization in the Cotton Belt:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Cooperation.*—Same as preceding project.

*Location.*—Washington, D. C., and cotton belt.

*Date begun.*—1913.

*Results.*—Extensive field investigations have been made on a large number of farms and plantations in various parts of the cotton belt and the most efficient systems of management studied in detail. The following publications have been issued: Department Bulletins—492, "An Economic Study of Farming in Sumter County, Ga."; 648, "A Farm Management Study of Brooks County, Ga."; 651, "A Farm Management Study in Anderson County, S. C."; 659, "A Farm Management Study of Cotton Farms of Ellis County, Tex."; 665, "Status of Farming Conditions in the Lower Rio Grande Irrigated Districts of Texas"; and, 931, "Soy Beans in Systems of Farming in the Cotton Belt." A manuscript has been prepared entitled "Farm Practices that Increase Crop Yields—The Gulf Coast Region."

*Assignment.*—A. G. Smith, E. S. Haskell, M. A. Crosby.

*Proposed expenditures, 1918-19.*—\$11,220.

### **Farm Organization in the Corn Belt:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Coöperation.*—Same as preceding project.

*Location.*—Washington, D. C., and the corn belt.

*Date begun.*—1913.

*Results.*—Substantial progress has been made in the study and development of systems and methods of management which permit of a more efficient use of labor on farms in the corn-belt States. These systems aim to eliminate the difficulties with labor arising at rush seasons by the use of live stock to harvest certain crops and by so arranging the cropping system as to better distribute the labor throughout the season. Much valuable material has also been collected with reference to the maintenance of crop yields through efficient rotations and improved farm practices. The following publications have been issued: Department Bulletin 694, "A Study of Farm Management Problems in Lenawee County, Mich."; and Farmers' Bulletins—614, "A Corn-Belt Farming System Which Saves Harvest Labor by Hogging Down Crops," and 716, "Management of Sandy-land Farms in Northern Indiana and Southern Michigan."

*Assignment.*—J. A. Drake, R. N. Thompson, J. C. Rundles.

*Proposed expenditures, 1918-19.*—\$10,920.

### **Farm Organization in the Great Plains Region:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Cooperation.*—Same as preceding project.

*Location.*—Washington, D. C., and Middle West or Plains region.

*Date begun.*—1913.

*Results.*—Farm-organization studies in this district have just been fully organized and only preliminary results are available. A manuscript entitled "Some Facts Concerning Grain Farming in North Dakota" has been prepared for publication.

*Assignment.*—J. H. Arnold.

*Proposed expenditures, 1918-19.*—\$10,311.



**Farm Organization in the Pacific-Coast and Rocky-Mountain Region:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Cooperation.*—Same as preceding project.

*Location.*—Washington, D. C., and the Pacific-coast and Rocky-Mountain region.

*Date begun.*—1913.

*Results.*—Field investigations with reference to the problems of farm organization in the Palouse country in Washington and the irrigated valleys of the Mountain States have been made on a large number of farms. These studies have been analyzed and the results prepared for publication. Special attention has been given to studies of improved farm practices which have insured good crop yields and made for efficiency of labor and machinery. Attention has also been given to systems of live-stock farming on irrigated areas with a view to determine proper rotations and the most efficient cropping systems for this type of farming. The following are some of the publications dealing with the agricultural practices in this district: Department Bulletin 625, "Cropping Systems for the Moisture Portion of Eastern Washington and Oregon and Northern Idaho"; and Farmers' Bulletins—294, "Farm Practice in the Columbia Basin Uplands"; 561, "Bean Growing in Eastern Washington and Oregon and Northern Idaho"; and 599, "Pasture and Grain Crops for Hogs in the Pacific Northwest." Extensive studies have also been made of irrigated areas in Arizona, New Mexico, and southern California. In these studies special attention has been given to those farm practices which have proved most beneficial and profitable in the various systems of farming practiced. On account of the recent development of agriculture in some of these districts, considerable attention has been given to the new types of farming that are being taken up, with a view to work out the most profitable cropping systems and methods of management. Results have also been obtained on certain systems of live-stock farming which have proved especially profitable from the standpoint of maintenance of fertility and the minimum expenditure for labor and feeds.

*Assignment.*—Byron Hunter, S. O. Jayne, R. W. Clothier, Levi Chubbuck.  
*Proposed expenditures, 1918-19.*—\$12,820.

**Total, Application of Farm Economics to Farm Practice, \$60,881, including \$5,160 statutory.**

**COOPERATIVE FARM-MANAGEMENT INVESTIGATIONS.****Cooperative Farm-Management Investigations in the Southern States:**

*Object.*—To ascertain the relative importance of the principal economic factors that influence successful farm management and to give the extension divisions of the State agricultural colleges the benefit of these investigations; to cooperate with these agencies in demonstrating to farmers practical methods of keeping farm records, in order that they may be enabled to analyze the business of their farms for the purpose of measuring the efficiency with which the farms have been managed and to decide on readjustments that promise to increase the net income.

*Procedure.*—Farm-management specialists are placed in those States in which complete cooperation is established. These specialists, acting with and through extension officials and the county agents, work among the farmers in the twofold capacity of investigators and demonstrators. As investigators they make studies of the prevailing farm practices and methods of management in communities of farmers to ascertain the degree to which these practices and methods of management comply with known economic facts and principles that underlie successful farming. As demonstrators they instruct the farmers in the importance of these economic facts and principles and assist them in so adjusting their practices and management as to conform more nearly, if possible, to these principles. They also instruct the farmer in making inventories of his land, implements, live stock, and supplies and in keeping records of his business transactions throughout the year and from year to year. These yearly records are then made the basis for measuring the degree to which his individual management conforms to economic law and the best known practices for the community and also for determining such adjustments in his practice as promise to increase the net income of his farm.



*Cooperation.*—Office of Extension Work in the Southern States, States Relations Service; and the extension division of the State agricultural colleges.

*Location.*—Throughout the 15 Southern States.

*Date begun.*—1917.

*Results.*—Thus far full cooperation has been established with four States, partial cooperation with three, and four others are ready for cooperation as soon as men and funds are available. A form of farm record book has been prepared by this office and adopted by eight of the States and is now in the hands of several hundred farmers. Eleven community surveys have been made covering 1,030 farms, and from one to six individual statements or circular letters based on these records have been sent back to the farmers. Numerous articles based on these records have been published in local farm papers.

*Assignment.*—C. L. Goodrich, C. E. Hoke, J. M. Johnson, A. D. McNair, F. D. Stevens.

*Proposed expenditures, 1918-19.*—\$25,182, including \$900 statutory.

**Total, Investigations in Farm Organization, \$149,843, including \$20,660 statutory.**

[Research.]

## **SPECIAL FARM-MANAGEMENT AND FARM-PRACTICE PROBLEMS.**

### **History and Distribution of Farm Enterprises:**

*Object.*—To determine the geographic factors which control the distribution of the various crops and types of live stock in this country. This project involves a study of the history of farming with the view of gaining further insight into the forces that determine the distribution of agricultural enterprises.

*Procedure.*—A great deal of geographic and statistical data is compiled, the work being conducted largely in cooperation with the various bureaus of this department and with the Bureau of Census in the Department of Commerce.

*Cooperation.*—Various bureaus of this department, the Census Bureau, and the Wisconsin Experiment Station.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Results.*—Substantial progress has been made in the preparation of maps, charts, etc., showing the distribution of various crops and types of live stock in this country, for the "Atlas of American Agriculture." The following sections of the "Atlas of American Agriculture" have been published: "Precipitation," "Cotton," "Rural Population," "Relief Map of the United States," besides various base maps for use in the atlas. Articles entitled "The World's Wheat Supply" and "A Graphic Summary of Seasonal Work on Farm Crops" have been published in the Department Yearbook for 1917. Other sections of the Atlas which are prepared and ready for publication are those dealing with "Temperature, Sunshine, and Wind," "Natural Vegetation and Life Zones," "Sheep," and "Horses and Mules." In addition to the sections for the "Atlas of American Agriculture," an atlas entitled "A Geography of the World's Agriculture," has been published.

*Assignment.*—O. E. Baker, O. C. Stine, C. L. Holmes.

*Proposed expenditures, 1918-19.*—\$30,300.

### **Farm Practices in Their Relation to Crop Yields:**

*Object.*—To determine the effect of certain farm practices on crop yields with reference to different types of soils.

*Procedure.*—Cooperative experiments are in progress with the Kentucky Experiment Station, in which various rotations, cropping systems, and other means of supplying humus are being tried out, and with individual farmers, in which tests are made as to the effectiveness and practicability of supplying humus by turning under nonleguminous crops such as corn, sorghum, millet, etc. Field investigations are made to determine the extent and use of clover as a means of building up and maintaining crop yields, also to investigate the practices as worked out by farmers in certain regions who have been especially successful in growing legumes to maintain high crop yields. The results of these studies of improved practices on the most successful farms are compiled and made available in bulletins.



*Cooperation.*—Other bureaus and offices of the department, the Kentucky Experiment Station, and individual farmers.

*Location.*—Washington, D. C., and various areas throughout the country.

*Date begun.*—1912.

*Results.*—Statistical data have been compiled with reference to the crop yields on more than 1,600 farms. Part of the results have been published in Circular 57, "The Relative Influence of Intertilled and Other Classes of Crops on Crop Yields." The results of certain farm practices in the use of barnyard manure have been studied and prepared for publication in a manuscript entitled "Handling Barnyard Manure in Eastern Pennsylvania." Other publications dealing with the improved practices and their effect on crop yields in different areas are nearly completed.

*Assignment.*—D. A. Brodie, J. S. Cates.

*Proposed expenditures, 1918-19.*—\$9,606.

### **Farm Bookkeeping and Accounting:**

*Object.*—To investigate and determine practical methods of farm bookkeeping and accounting.

*Procedure.*—Studies are made of various existing systems of bookkeeping as worked out by farmers in different parts of the country and by other individuals interested in that line of research. Records are also kept of a number of farms to test the practicability of different methods.

*Cooperation.*—New York, Wisconsin, and Minnesota experiment stations.

*Location.*—Washington, D. C., and various farms in different parts of the country.

*Date begun.*—1906.

*Results.*—Studies have been made on the practicability of various systems of farm bookkeeping and accounting which have been found to be suited to the farmer's needs. Information regarding these systems and instructions for their use are contained in Farmers' Bulletins 511, 572, 661, and 782.

*Assignment.*—J. S. Ball, E. H. Thomson.

*Proposed expenditures, 1918-19.*—\$8,266.

**Total, Special Farm-Management and Farm-Practice Problems, \$48,172, including \$15,300 statutory.**

**(Clearing and Utilization of Logged-Off Lands:** The work carried on under this project included an investigation of the methods used by farmers in clearing logged-off land, the estimated costs of such methods, the systems of farming developed, and the means by which the farmer and his family have made their living while the land was being cleared. The results of the work have been published as Farmers' Bulletin 974, "Clearing Land." The appropriation for this work was discontinued on June 30, 1917, since which time no field work has been done.)

(See also Supplement—Emergency Activities, p. 550.)

## WEATHER BUREAU.

### GENERAL ADMINISTRATION.

#### General Administration:

*Object.*—To direct the policy and business affairs of the bureau and to supervise its scientific activities.

*Location.*—Washington, D. C.

*Date begun.*—1891 (date of transfer of meteorological work to the Department of Agriculture; meteorological work began November 1, 1870, under War Department, Signal Corps, U. S. A.)

*Assignment.*—C. F. Marvin, chief; C. C. Clark, assistant chief; E. B. Calvert, chief clerk.

*Proposed expenditures, 1918-19.*—\$79,690, including \$46,600 statutory (service, \$74,590; research, \$5,100).

[Service.]

### COLLECTION AND DISSEMINATION OF METEOROLOGICAL, CLIMATOLOGICAL, AND MARINE INFORMATION.

#### Forecasts and Warnings:

*Object.*—To take, record, encipher, telegraph, compile, and tabulate regular meteorological observations, and to care for and maintain the instrumental equipment therefor; to issue weather forecasts twice daily, including frost, cold-wave, storm, and small-craft warnings at the district forecast centers for their respective districts as follows: Washington, D. C., district: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, West Virginia, Kentucky, Tennessee, Ohio, Indiana, Michigan, and upper and lower Lakes; Chicago, Ill., district: Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Nebraska, South Dakota, North Dakota, Montana, and Wyoming; Denver, Colo., district: Colorado, Utah, New Mexico, and Arizona; San Francisco, Cal., district: California, Nevada, Washington, Oregon, and Idaho; New Orleans, La., district: Louisiana, Arkansas, Texas, and Oklahoma; to issue storm warnings for the West Indies and the Caribbean Sea, including the Panama Canal Zone and coasts adjacent thereto; to issue special wind forecasts in connection with forest-fire prevention, shippers' forecasts, and other special forecasts in the interests of manufacturing, commerce, and agriculture at selected stations; to prepare daily weather forecasts at selected stations for their immediate vicinity; also to print the same or issue by other means, and disseminate by maps, bulletins, flags, forecast cards, and telegraph and telephone messages; to prepare reports for the press of weather synopses, forecasts, and full and complete information concerning the current local weather conditions in all their phases.

*Location.*—Washington, D. C., Chicago, Ill., San Francisco, Cal., Denver, Colo., New Orleans, La., and 197 other stations (designated by letter "A" under table "Distribution of work and expenditures by stations").

*Date begun.*—1891.

*Assignment.*—H. E. Williams, E. H. Bowie, H. C. Frankenfield, A. J. Henry, H. J. Cox, E. A. Beals, F. H. Brandenburg, I. M. Cline.

*Proposed expenditures, 1918-19.*—\$999,735.



**River and Flood Forecasting:**

*Object.*—To establish and maintain river-gauging stations and substations which observe and report rainfall, river stages, and weather conditions; to disseminate information concerning river stages, especially in times of flood or expected flood, to persons and interests most directly benefited thereby.

*Location.*—Washington, D. C., and 65 other stations (designated by letter "B" under table "Distribution of work and expenditures by stations").

*Date begun.*—1891.

*Assignment.*—A. J. Henry and officials in charge of the various river districts.

*Proposed expenditures, 1918-19.*—\$186,450.

**Climatological Work:**

*Object.*—To collect, compile, chart, and discuss climatological data of the United States and its adjacent oceans and outlying territories; to print and promptly disseminate the information to the public, to commercial exchanges, and to all parties and organizations interested in or benefited by the service that can be promptly reached by the usual means of communication available; to collect, and compile for publication marine meteorological and climatological data, including that furnished to the Hydrographic Office for publication on the pilot charts.

*Cooperation.*—Hydrographic Office, Navy Department.

*Location.*—Washington, D. C., and the various section and special reporting centers (designated by letter "C" under table "Distribution of work and expenditures by stations").

*Date begun.*—1891.

*Assignment.*—P. C. Day and officials in charge of section and special reporting centers.

*Proposed expenditures, 1918-19.*—\$400,810.

**Agricultural Meteorology:**

*Object.*—To collect and disseminate information relative to the effect of current weather conditions on farm activities, the growth of vegetation, and the development of crops, and to disseminate from time to time during the growing season information as to the advancement of crops as compared with an average season, for the benefit of farm labor distribution and requirements; also to give advice and disseminate information relative to the utilization of the special forecasts and warnings issued by the Weather Bureau in the interests of various lines of agriculture and stock raising.

*Procedure.*—Daily telegraphic reports are collected from selected substations, reporting in the interests of cotton, corn, wheat, sugar, rice, tobacco, and other crops, for publication and dissemination to the public. A weekly report of the total rainfall, snowfall, highest and lowest temperatures, and the condition of the ranges in Texas, New Mexico, Arizona, and Utah is collected and published for the benefit of stock interests. Weekly summaries of weather and crop conditions are issued to commercial exchanges and to all persons and organizations interested in or benefited by the service that can be promptly reached by the usual means of communication available.

*Location.*—Washington, D. C., and the various special crop-reporting centers (designated by letter "D" under table "Distribution of work and expenditures by stations").

*Date begun.*—1891.

*Results.*—(1) During 1918: Daily observations of temperature and rainfall are being made at 168 special cotton-region stations and telegraphed to district centers. Daily cotton-region bulletins are being issued at 27 stations, with a total issue of 2,377 copies. Daily observations of temperature and rainfall are being made at 186 special corn and wheat region stations and being telegraphed to district centers. Daily corn and wheat region bulletins are being published at 19 stations, with a total issue of 3,132 copies. Daily observations of temperature and rainfall are being made at 51 special cattle-region stations and telegraphed weekly to district centers. (Daily snowfall, depth of snow on the ground, and condition of ranges is being telegraphed during the winter.) Weekly bulletins



are being published at 4 stations, with a total issue of about 1,000. Daily observations of temperature and rainfall are being made at special stations in fruit, tobacco, alfalfa, and cranberry districts and telegraphed during critical frost periods to frost-warning centers. Weekly information of the effect of weather upon crops is being collected at 44 State centers and telegraphed to Washington and many of them also to region centers. Weekly weather and crop bulletins are being published at Washington, Chicago, New Orleans, and San Francisco, covering large areas, and in a less detailed degree at each State center. The total issue of these bulletins weekly is approximately 30,000.

(2) Prior to 1918: These services have gradually developed, have been carried on in practically the same manner, and results published and disseminated as indicated above.

*Assignment.*—J. Warren Smith and officials in charge of various Weather Bureau stations and substations.

*Proposed expenditures, 1918-19.*—\$86,950.

### **Vessel Reporting:**

*Object.*—To collect at certain Atlantic, Pacific, and Gulf stations of the Weather Bureau information regarding the passage of vessels at sea and to transmit this information for the benefit of commerce and navigation and for national defense.

*Location.*—Cape Henry, Va., Port Angeles, Tatoosh Island, and North Head, Wash., and Point Reyes Light, Cal. (designated by letter "F" under table "Distribution of work and expenditures by stations").

*Date begun.*—1891.

*Assignment.*—Officials in charge of stations indicated in table beginning on page 29.

*Proposed expenditures, 1918-19.*—\$11,750.

**Total, Collection and Dissemination of Meteorological, Climatological, and Marine Information, \$1,685,695, including \$269,850 statutory.**

[Research.]

## **INVESTIGATION AND RESEARCH.**

### **Improvement of Instrumental Equipment:**

*Object.*—To select, test, improve, and design instrumental equipment for the scientific work of the bureau.

*Location.*—Washington, D. C.

*Date begun.*—1891.

*Results.*—(1) During 1918 the following equipment was designed: A special simplified form of wind vane, a new ball bearing for wind vane, a simplified form of indicating Robinson anemometer, a new instrument shelter for use in fruit orchards, a new standardized pattern of ombroscope for recording the time of occurrence of rain, special thermographs for use in studies of frost, improved apparatus for testing thermometers and thermographs, and special clocks with wide time scale for use in aviation or aerology. Considerable progress has been made with new designs for kites and meteorographs for use with kites or airplanes, as well as with a new nephoscope, adapted either to station or field use.

(2) Prior to 1918: Equipment designed includes the Marvin precision barograph, Marvin seismograph, and the Marvin pyrliometer, kites and meteorographs for the exploration of the upper air, and evaporation and snow-measuring instruments. Constants of the psychrometric formulæ have been determined. A series of circulars of instructions have been published for (a) obtaining and tabulating records from recording instruments, (b) cooperative observers, (c) installation and maintenance of wind measuring and recording apparatus, (d) measurement of precipitation, (e) barometers and the measurement of atmospheric pressure, (f) care and management of electrical sunshine recorders, (g) aerial observers, and (h) installation and operation of class "A" evaporation stations. Weather Bureau psychrometric tables have been published.

*Assignment.*—B. C. Kadel, S. P. Fergusson.

*Proposed expenditures, 1918-19.*—\$1,500.



**Investigations of the Problems of Forecasting:**

*Object.*—To improve the accuracy of and extend the time covered by the forecasts and warnings, and to formulate rules and enunciate principles in connection therewith.

*Location.*—Washington, D. C.

*Date begun.*—1891.

*Results.*—(1) During 1918: A study of the temperature distribution in cyclones and anticyclones was completed.

Studies in relation to the extension of the period covered by the forecasts are still under way.

The improvement in the weekly forecasts has not been as satisfactory as was anticipated. The investigations are being continued in the hope of ascertaining more definitely the underlying causes of storm development and movement, especially the bearing thereon of the pressure distribution over the Pacific Ocean and Alaska.

(2) Prior to 1918: Investigations and improvements have been made from time to time in the methods of forecasting day-to-day weather and temperature, cold waves, frosts, gales, heavy snows, and hurricanes, resulting in increased accuracy and range.

*Assignment.*—A. J. Henry, H. C. Frankenfield, E. H. Bowie, C. A. Donnel, F. G. Tingley.

*Proposed expenditures, 1918-19.*—\$3,550.

**River and Flood Investigations:**

*Object.*—To improve methods of flood forecasting; to determine the amount of snow and its water content in mountain districts of Western States.

*Location.*—Washington, D. C., and other river centers.

*Date begun.*—1891.

*Results.*—(1) During 1918: Depth and density measurements were made in the heavy snow fields of the Sierra Nevada to determine by test the change in density with increase in depth. A study of depth and density measurements of snow in Western States was brought to a conclusion; data published in *Monthly Weather Review* 45:102.

Plans have been approved for a snow survey on the headwaters of the White River of Arizona.

A brief study has been made of the ratio of the maximum flood to the average high water in the principal rivers.

To obtain the fundamental data of precipitation in the mountain districts of Los Angeles County, Cal., measurements of precipitation have been instituted at 39 different points and the results summarized.

(2) Prior to 1918: The relation between rainfalls of varying intensity and the resulting stages in the principal rivers of the United States has been more or less completely determined, and rules have been formulated for use in the preparation of flood warnings.

*Assignment.*—A. J. Henry and officials in charge of the various river and climatological districts.

*Proposed expenditures, 1918-19.*—\$3,850.

**Investigations in Climatology:**

*Object.*—To determine more fully the climate of the entire United States, including the insular possessions.

*Cooperation.*—Several bureaus of the department, other departments, State agricultural and meteorological organizations, and colleges.

*Location.*—Washington, D. C.

*Date begun.*—1891.

*Results.*—(1) During 1918: The preparation of climatological data for the proposed *Atlas of American Agriculture* was continued, and the remaining sections on climate assigned to the Weather Bureau, consisting of numerous charts and diagrams illustrating all important phases of temperature, wind, humidity, sunshine, etc., together with necessary text matter, were practically completed and placed in the hands of the committee having final charge of the publication.

A brief résumé of the more important climatic features of France and Belgium was prepared in pamphlet form and given wide distribution.

Complete statistics of current weather conditions at nearly 5,000 different points well distributed over the United States and its possessions were published monthly at the several State or Territorial centers and widely



distributed. These were in time supplemented by annual publications briefly summarizing the more essential data presented in the monthlies.

Material illustrating by charts and otherwise the occurrence of tornadoes and hailstorms was prepared. It is proposed to enlarge this feature of the work of the bureau during the present year by covering the country more completely than ever before with reporters and investigating more fully all reports of their occurrence.

The reprinting, by sections, of a number of the important sections of Climatological Data (Bulletin W) was accomplished during the year, and as a result much needed data have been supplied for use in furnishing weather information to numerous inquirers.

The usual bulletins showing the snow and ice conditions over the country during the winter were issued, and those prepared for the separate States in the mountain regions of the West were somewhat enlarged over those of preceding years.

The charting of weather data over the North Atlantic Ocean continued, but the number of reports steadily diminished on account of the scarcity of shipping, due to conditions attending the war. Steps were taken to secure a more extensive weather-reporting service over the vast North Pacific area, and gratifying progress is being observed.

The work of furnishing climatological data upon public requests has continued, and much information of importance in connection with their greatly enlarged military operations has been made available for the various Government departments.

(2) Prior to 1918: Numerous separate reports have been prepared on the weather and climate of the different portions of the country, including mainly Bulletin V, a treatise on the frosts of the United States; Bulletin W, a general summary of the important weather data of the United States in 106 separate parts; and Supplement 6, "The Humidity and Vapor Pressure of the United States." The section of the proposed Atlas of American Agriculture assigned to the Weather Bureau, treating of the occurrence and distribution of precipitation in the United States, was prepared and submitted for final publication.

The bureau has published, in addition, numerous climatic charts and bulletins for the country as a whole and for individual sections and has discussed more or less fully for many years the general weather from month to month and year to year.

*Assignment.*—P. C. Day.

*Proposed expenditures, 1918-19.*—\$5,990.

### **Investigation of the Relation Between Climate and Weather and Crop Development:**

*Object.*—To determine the effect of current meteorological factors upon the growth of vegetation; to conduct studies of meteorological and climatological conditions in their relations to the growth of plants, the yield of crops, and the distribution of crop areas.

*Procedure.*—Systematic and well-organized plans are being developed for keeping simultaneous meteorological and phenological records in the principal crop districts for the purpose of determining the critical periods in the growth of crops, as well as in the development of insect activities and fungous diseases, and the records of weather conditions and crop yields obtained during past years are being correlated.

*Cooperation.*—State experiment stations, various bureaus of the department, and individuals.

*Location.*—Washington, D. C., local Weather Bureau offices, and experiment stations and farms in different States.

*Date begun.*—1916.

*Results.*—(1) During 1918: This bureau and other bureaus of the department cooperated in determining the relation between the weather and crop development, insect activities, plant diseases, and diseases of animals at Albany and Lockport, N. Y., Ames, Iowa, Amherst and East Wareham, Mass., Aroostook, Me., Boise and Priest River, Idaho, Brooksville, Miami, and Quincy, Fla., Clemson College, Florence, and Whitehall, S. C., East Falls Church, Va., Kanawah Station, W. Va., Madison, Wis., Pah-rump, Nev., Raleigh, N. C., and Yarrow, Md. Meteorological instruments are also in the hands of officials of different bureaus, classified as "cooperative observers," at other places.



(2) Prior to 1918: A partial study of the relation between temperature and rainfall and crop yields during past years has shown that rainfall is the most important factor in the varying of the yield of corn in the great corn-growing districts of the United States; that the most important calendar month in this respect is July and the most important 10-day period the first 10 days of August. From a crop-growth point of view the most important 10 days are the 10 days following blossoming. The correlation shows that in this region of the country the greater the rainfall the greater the yield of corn. A partial study of the relation between weather and potato yield shows that temperature is the most important factor in varying the yield in the greater part of the United States and that this crop is unfavorably affected by high temperatures. In the Ohio valley and lower Lake region July is the most important calendar month; a comparison of these data covering 60 years shows that the cooler the month of July the better the potato yield. The studies show, further, that late blight of potato (*Phytophthora infestans*) makes its best development with average daily temperatures of close to 72° and that in the extreme northern portions of the United States the temperature must be higher than the normal, with considerable atmospheric moisture, to cause a serious outbreak of this disease, while somewhat farther south, as, for example, in northern Ohio, the season must be cooler than the normal in order to cause a serious development of the disease.

*Probable date of completion.*—1927.

*Assignment.*—J. Warren Smith and officials at various Weather Bureau stations.

*Proposed expenditures, 1918-19.*—\$7,560.

### **Aerological Investigations:**

*Object.*—To obtain free-air data in different parts of the United States, with the purpose of making these data immediately available for the information and assistance of the Forecast Division of the Weather Bureau, the aviation training fields, and aviators flying over such trans-continental mail and other aerial routes as may be established; and to summarize, study, and publish these data, with the purpose of furnishing reliable information as to mean free-air conditions of pressure, temperature, humidity, density, and wind direction and velocity, by months and seasons, under different types of pressure distribution at the surface and in different parts of the country, for the information and benefit of the aviation and artillery services of the Army and Navy and for the purpose of increasing our knowledge of the dynamics of the atmosphere.

*Procedure.*—Suitable sites for aerological stations are selected, at which kite-flying equipment is installed. Daily flights to as great heights as possible are made and, in addition, whenever conditions are favorable, series of successive flights, continuing from 30 to 40 hours, are made for the study of diurnal variation. Some work is done with pilot balloons in connection with thunderstorm studies and wind conditions when kite flights can not be made.

*Cooperation.*—Chief Signal Officer, United States Army. This service is providing for and maintaining during the war aerological and meteorological observations at a number of aviation and artillery fields. The data obtained by the Weather Bureau and by the Signal Corps are made mutually available for the purpose of charting wind and free-air conditions prevailing at any given time and over different parts of the country.

*Location.*—Supervisory office at Washington, D. C.; field stations at Broken Arrow, Okla., Drexel, Nebr., Ellendale, N. Dak., Groesbeck, Tex., Leesburg, Ga., and Royal Center, Ind.

*Date begun.*—1914.

*Results.*—(1) During 1918: Observations were made at Drexel, Nebr., and Ellendale, N. Dak. Additional stations are now being equipped at Broken Arrow, Okla., Groesbeck, Tex., Leesburg, Ga., and Royal Center, Ind.

(2) Prior to 1918: Observations and data obtained have been regularly published as aerological supplements of the Monthly Weather Review, and technical papers based on free-air data have been published in the annual report of the National Advisory Committee for Aeronautics. Information has been regularly supplied to the military and other branches of the Government and to the public.

*Assignment.*—W. R. Gregg, V. E. Jakl, H. W. Ball, T. J. Chancellor, F. J. Bavendick, F. T. Cole, J. A. Reible.

*Proposed expenditures, 1918-19.*—\$104,740.



**Solar Radiation Investigations:**

*Object.*—To determine the intensity of the light and the total amount of heat received directly from the sun or diffusely from the sky under differing atmospheric conditions and at different times of the day and seasons of the year; to obtain normals of insolation in terms of both heat and light; to investigate the relation between skylight polarization and insolation on clear days; to determine the relation between atmospheric conditions and nocturnal radiation.

*Location.*—Washington, D. C., Madison, Wis., Santa Fe, N. Mex., and Lincoln, Nebr.

*Date begun.*—1913.

*Results.*—(1) During 1918: The effect of city smoke upon daylight illumination was determined; improved instrumental equipment for measuring direct solar radiation devised; improvement effected in radiation normals; the rate of nocturnal radiation determined.

(2) Prior to 1918: The intensity of twilight and its duration in different latitudes under clear-sky conditions was determined; also the shading effect of wire insect cages and of different kinds of netting used by tobacco growers. Summaries showing diurnal and annual variations in solar radiation and also nonperiodic variations, with daily, monthly, and annual departures from normal values, expressed in heat units, have been published.

*Assignment.*—H. H. Kimball, I. F. Hand, W. D. Bancroft.

*Proposed expenditures, 1918-19.*—\$7,740.

**Evaporation Investigations:**

*Object.*—Primary: To determine under standard conditions of exposure the relative values of evaporation in various portions of the United States. Secondary: To establish the relation between the evaporation under the above standard conditions and the climatological factors that combine to bring it about.

*Cooperation.*—Reclamation Service, Geological Survey, Forest Service, Bureau of Plant Industry, Bureau of Public Roads, State organizations, and private parties.

*Location.*—Washington, D. C., Mesa, Roosevelt, Willcox, and Yuma, Ariz., Tahoe and Manteca, Cal., Arrowrock Reservoir and Deer Flat Reservoir, Idaho, Lawrence, Tribune, and Wellington, Kans., Gardiner, Me., Silver Hill, Ala., Columbia, Mo., Bozeman and Valier, Mont., Elephant Butte, Santa Fe, and Tucumcari, N. Mex., Indian Springs, Lamoile, and Marlette Lake, Nev., Wooster, Ohio, San Juan, Porto Rico, Rapid City, S. Dak., Austin and Laredo, Tex., Albany, N. Y., and Walla Walla, Wash.

*Date begun.*—1915.

*Results.*—(1) During 1918: Observations are being published in the section reports of the several States, beginning with the annual summaries for 1916.

(2) Prior to 1918: Evaporation equipment was standardized and installed.

*Assignment.*—B. C. Kadel.

*Proposed expenditures, 1918-19.*—\$4,565.

**Meteorological Investigations:**

*Object.*—To determine the nature of meteorological phenomena and the laws of their actions.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) During 1918: A serial, "Physics of the Air," has been run during the whole year in the Journal of the Franklin Institute, with the cooperation of the Weather Bureau. A large amount of additional material, relating especially to meteorological optics, has been prepared and is ready for publication.

(2) Prior to 1918: The physical basis of Egnell's law, or explanation why the wind velocity increases with altitude at approximately the same rate that the density decreases, has been explained. A paper entitled "General Circulation of the Atmosphere" has been prepared for publication as Chapter II of the Forecast Manual. The reason why the temperature of the atmosphere changes comparatively little with elevation beyond the



level of 10 to 11 kilometers has been explained. It has been discovered from balloon records that, generally, the troposphere (atmosphere up to about 11 kilometers) is warmer in anticyclonic than in cyclonic regions, and that the stratosphere (atmosphere beyond about 11 kilometers) is colder in anticyclonic than in cyclonic regions. These results were, in part, quite unexpected but have been abundantly confirmed by other students of this problem. The reason for the location of the permanent and semipermanent ocean "highs," 5 in number, and "lows," 2 in number, at their respective places has been explained. It has also been explained why clouds occur far more frequently at certain levels (five) than at any others. A theoretical and historical discussion of the effect of volcanic dust on the temperature of the atmosphere, with a number of new and interesting conclusions, has been presented; also a discussion, involving much that is new, of the thunderstorm and its phenomena.

*Assignment.*—W. J. Humphreys.

*Proposed expenditures, 1918-19.*—\$2,275.

### Seismological Investigations:

*Object.*—To map the United States according to seismological activity and locate geological faults; to study in detail earthquake vibrations and draw inferences therefrom in regard, on the one hand, to the scientifically important problem of the structure of the earth and, on the other, to the practical question of types of building best adapted to withstand seismic shocks.

*Cooperation.*—Geological Survey.

*Location.*—Washington, D. C., Northfield, Vt., Chicago, Ill., and San Francisco, Cal.

*Date begun.*—1914.

*Results.*—(1) During 1918: A seismic map of the United States, based on the 112 earthquakes felt in this country during the calendar year 1917, was constructed.

(2) Prior to 1918: Seismic maps of the United States, based on the 131 earthquakes felt during the calendar year 1916 and the 150 earthquakes felt during the calendar year 1915, were constructed.

*Assignment.*—W. J. Humphreys.

*Proposed expenditures, 1918-19.*—\$2,355.

**(Investigations in Agricultural Meteorology:** This project has been superseded by "Investigation of the Relation between Climate and Weather and Crop Development.")

### Ice-Storm and Sleet Investigations:

*Object.*—To enable the Weather Bureau to meet the demands from telegraph and telephone companies, electric-power transmission companies, horticulturists, students, etc., for information relating to ice storms and sleet; to improve and extend the issue of forecasts and warnings of the approach of such storms; and to collect and publish statistical data thereon showing distribution, frequency, and severity of ice storms, including details concerning the accompanying winds and other allied weather conditions, the thickness, weight, and damaging effects of ice coatings to vegetation, overhead-line construction, etc.

*Cooperation.*—Bureau of Standards and private firms, corporations, and individuals.

*Location.*—Washington, D. C.

*Date begun.*—1916.

*Results.*—(1) During 1918: Regular observations of ice, sleet, and snowstorms were made and monthly reports rendered. But few sleet storms of any importance occurred, and therefore further data must be obtained before it will be possible to formulate reliable conclusions.

(2) Prior to 1918: The work done under this project was limited to the work of planning, organization, and the collection of one year's data. The cooperation of various electric-light, power, and traction companies was enlisted and the proposed field surveyed. This was done in the spring of 1916.

*Assignment.*—W. J. Humphreys, H. C. Frankenfield.

*Proposed expenditures, 1918-19.*—\$250.



**Investigations of Frost-Protection Methods:**

*Object.*—To determine the most economical and efficient methods of frost protection now in use and to improve such methods; to investigate meteorological and climatological conditions at typical key stations in different fruit and truck producing areas; and to coordinate these conditions with those in other sections where frost-protection methods are practicable under similar or different topographic conditions with similar or varying air drainage, isothermal layers, etc., so that the most accurate minimum temperature forecasts may be made for these different districts.

*Procedure.*—Investigations are being conducted in the important fruit sections for the purpose of determining the most economical and efficient methods of frost protection now in use. Studies are made of all possible existing quantitative data bearing on the amount of fuel consumption and the methods of artificially heating orchards that have been applied, together with the influence of such protection on the atmospheric temperature conditions. Tests are made of the various types of orchard-heating apparatus and the amount of heat necessary for the protection of the various fruit and truck crops in different locations determined. Thermal surveys necessary to determine the stratification of the air and the influence of artificial heating on the temperature thereof are conducted. The heating influence is correlated with meteorological factors in different mountain valleys where the atmospheric strata are affected by different topographical factors.

*Cooperation.*—State experiment stations, various bureaus of the department, fruit and truck growing organizations, and individual orchardists and gardeners.

*Location.*—Washington, D. C., local Weather Bureau offices, State experiment stations, and orchards and farms in different States.

*Date begun.*—1917.

*Results.*—(1) During 1918: At Pomona, Cal., and in the Rogue River Valley, Oreg., studies were made in connection with the protection of crops from frost to determine the temperature distribution, air drainage, and the effects of artificial heating. Data were obtained and tabulated at about 30 stations in different parts of the country with a view to determine normal temperature variations and to prepare hygrometric formulæ to improve minimum temperature forecasts.

(2) Prior to 1918: A general survey was made in various fruit-frost districts in Oregon, Idaho, Utah, Colorado, New Mexico, Arizona, and California. Special stations were located in the citrus-fruit region of southern California, the deciduous-fruit region of northern California, and the deciduous-fruit region in the Rogue River Valley, Oreg., for the purpose of making investigations to determine the temperature variation, air drainage, and the thermal efficiency and effect on orchards of various heating devices with a view to improve these devices. Thermal surveys have been made in the fruit region in western North Carolina and in the Salt River Valley in Arizona.

*Probable date of completion.*—1927.

*Assignment.*—J. Warren Smith, Floyd D. Young.

*Proposed expenditures, 1918-19.*—\$650.

**Investigations in Volcanology:**

*Object.*—Investigation of volcanoes and related phenomena.

*Procedure.*—The Weather Bureau will take over the Hawaiian Volcano Observatory and equipment at Kilauea volcano, Island of Hawaii, and continue the work on volcanology which has been carried on by the Hawaiian Volcano Research Association for a number of years. The work may be extended to California and elsewhere if facilities warrant.

*Cooperation.*—Hawaii Volcano Research Association.

*Location.*—Volcanoes of Hawaii and elsewhere, especially Kilauea, Island of Hawaii.

*Date begun.*—Originally in 1912; as a project of the Weather Bureau, July 1, 1918.

*Results.*—Twenty record books are on file containing weather data, photographs, crater measurements, notes, drawings, and charts. Illustrated bulletins giving a condensed history of the work have been published during the past five years.

*Assignment.*—C. F. Marvin; project leader to be appointed.

*Proposed expenditures, 1918-19.*—\$2,520.

**Total, Investigation and Research, \$147,545, including \$12,500 statutory.**



## DISTRIBUTION OF WORK AND EXPENDITURES BY STATIONS.

Location.	Character of work. <sup>1</sup>	Cooperation.	Date begun.	Assignment.	Proposed expenditures, 1918-19.
Abilene, Tex.....	A.....	.....	1885	William H. Green.....	\$2,500
Albany, N. Y.....	A, B.....	.....	1873	George T. Todd.....	6,800
Alpena, Mich.....	A, E.....	.....	1872	Frank Jermin.....	4,400
Amarillo, Tex.....	A, D.....	.....	1892	Thomas J. Considine..	4,100
Anniston, Ala.....	A.....	.....	1905	Robert H. Dean.....	1,800
Asheville, N. C.....	A, B.....	.....	1902	Thomas R. Taylor....	3,300
Atlanta, Ga. (section center).	A, B, C, D..	.....	1878	Charles F. von Hermann.	13,000
Atlantic City, N. J....	A.....	.....	1873	W. L. Day.....	3,100
Augusta, Ga.....	A, B, C, D..	.....	1870	Eugene D. Emigh.....	6,600
Baker, Oreg.....	A.....	.....	1911	William D. Maxwell..	1,700
Baltimore, Md. (section center).	A, C, D.....	Johns Hopkins University, Maryland State Weather Service.	1871	Oliver L. Fassig.....	10,000
Bentonville, Ark.....	A.....	.....	1906	Orin Parker.....	1,600
Binghamton, N. Y....	A, B.....	.....	1896	John R. Weeks.....	4,800
Birmingham, Ala.....	A, D.....	.....	1903	Edgar C. Horton.....	5,000
Bismarck, N. Dak. (section center).	A, B, C, D..	University of Dakota..	1874	Orris W. Roberts.....	8,500
Block Island, R. I.....	A, E.....	.....	1880	George W. Eddey.....	3,900
Boise, Idaho (section center).	A, B, C, D..	Forest Service, Reclamation Service.	1898	C. E. Norquest.....	7,600
Boston, Mass. (section center).	A, C, D.....	Blue Hill Observatory.	1870	John W. Smith.....	24,100
Buffalo, N. Y.....	A.....	Canisius College.....	1870	David Cuthbertson...	13,400
Broken Arrow, Okla...	A, G.....	War Department.....	1918	J. A. Reihle.....	12,000
Burlington, Vt.....	A.....	University of Vermont	1906	John K. Hooper.....	3,800
Cairo, Ill.....	A, B.....	.....	1871	William E. Barron....	4,950
Canton, N. Y.....	A.....	.....	1906	John S. Hazen.....	2,250
Cape Henry, Va.....	A, E, F.....	.....	1873	John F. Newsom.....	10,850
Charles City, Iowa.....	A.....	.....	1904	Hal P. Hardin.....	2,100
Charleston, S. C.....	A, B, C, D..	.....	1871	James H. Scott.....	7,650
Charlotte, N. C.....	A, D.....	.....	1878	Ora O. Atto.....	4,000
Chattanooga, Tenn...	A, B.....	.....	1879	Lewis M. Pindell....	8,450
Cheyenne, Wyo. (section center).	A, C, D.....	Forest Service, Reclamation Service.	1870	George W. Pitman....	7,150
Chicago, Ill. (district forecast center).	A, C, D, E...	University of Chicago.	1870	Henry J. Cox, Charles L. Mitchell.	53,000
Cincinnati, Ohio.....	A, B.....	.....	1870	William C. Devereaux	16,850
Cleveland, Ohio.....	A.....	Case Scientific School.	1870	Eben H. Emery.....	12,850
Columbia Mo. (section center).	A, C, D.....	University of Missouri	1889	George Reeder.....	5,400
Columbia, S. C. (section center).	A, B, C, D..	Clemson College, Charleston Museum.	1887	Richard H. Sullivan..	7,450
Columbus, Ohio (section center).	A, B, C, D..	Geological Survey, Hiram College, Oberlin College, Ohio State University, Ohio Experiment Station.	1878	William H. Alexander	15,750
Concord, N. H.....	A, B.....	.....	1902	Elisha C. Vose.....	3,350
Concordia, Kans.....	A.....	.....	1885	John W. Ryram.....	1,600
Corpus Christi, Tex...	A.....	.....	1887	Charles E. Heckathorn	4,400
Dallas, Tex.....	A, B.....	.....	1913	Joseph L. Cline.....	6,750
Davenport, Iowa.....	A, B.....	.....	1871	Julius M. Sherier....	6,620
Dayton, Ohio.....	A, B.....	.....	1911	R. F. Young.....	6,450
Del Rio, Tex.....	A.....	.....	1905	C. A. Parrack.....	1,540
Denver, Colo. (district forecast and section center).	A, B, C, D..	Forest Service, Reclamation Service, Colorado Agricultural College, Colorado State College.	1871	Frederick H. Brandenburg, Frederick W. Brist.	24,935
Des Moines, Iowa (section center).	A, B, C, D..	Iowa College and Experiment Station, Iowa State University, State Weather Service.	1878	C. D. Reed.,.....	8,450
Detroit, Mich.....	A.....	.....	1870	Norman B. Conger....	12,500
Devils Lake, N. Dak..	A.....	.....	1904	Martin R. Hovde.....	2,750
Dodge City, Kans.....	A.....	.....	1874	Harrison McP. Baldwin.	1,750

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*Distribution of work and expenditures by stations—Continued.*

Location.	Character of work. <sup>1</sup>	Cooperation.	Date begun.	Assignment.	Proposed expenditures, 1918-19.
Drexel, Nebr. ....	A, G. ....	War Department. ....	1914	V. E. Jakl. ....	\$12,000
Dubuque, Iowa. ....	A, B. ....	.....	1873	James H. Spencer. ....	5,460
Duluth, Minn. ....	A, D. ....	.....	1870	Herbert W. Richardson. ....	9,220
Eastport, Me. ....	A. ....	.....	1873	William H. Brunkow. ....	3,250
Elkins, W. Va. ....	A. ....	.....	1889	Olin M. Hadley. ....	3,100
Ellendale, N. Dak. ....	A, G. ....	War Department. ....	1917	F. J. Bavendick. ....	12,000
El Paso, Tex. ....	A. ....	.....	1878	Robert M. Shaver. ....	3,350
Erie, Pa. ....	A. ....	.....	1873	Harry O. Geren. ....	6,070
Escanaba, Mich. ....	A. ....	.....	1898	Harvey H. Spindler. ....	3,020
Eureka, Cal. ....	A, B. ....	.....	1886	James Jones. ....	3,170
Evansville, Ind. ....	A, B. ....	.....	1897	Albert Brand. ....	6,250
Fort Smith, Ark. ....	A, B. ....	.....	1882	Leon J. Guthrie. ....	5,160
Fort Wayne, Ind. ....	A, B. ....	.....	1911	Patrick McDonough. ....	5,580
Fort Worth, Tex. ....	A, D. ....	.....	1898	Dennis S. Landis. ....	4,460
Fresno, Cal. ....	A, B. ....	.....	1887	Walter E. Bonnett. ....	7,130
Galveston, Tex. ....	A, D. ....	.....	1871	Arthur H. Scott. ....	6,380
Grand Haven, Mich. ....	A. ....	.....	1905	Herbert Tullsen. ....	2,540
Grand Junction, Colo. ....	A, D. ....	.....	1899	Esek S. Nichols. ....	4,640
Grand Rapids, Mich. (section center). ....	A, B, C, D. ....	Michigan Experiment Station and University of Michigan. ....	1903	Charles F. Schneider. ....	9,130
Green Bay, Wis. ....	A. ....	.....	1886	Frederick W. Conrad. ....	2,960
Greenville, S. C. ....	A. ....	.....	1917	G. E. Merchant. ....	6,500
Groesbeck, Tex. ....	A, G. ....	War Department. ....	1918	T. J. Chancellor. ....	12,000
Hannibal, Mo. ....	A, B. ....	.....	1892	Bion L. Waldron. ....	3,500
Harrisburg, Pa. ....	A, B. ....	.....	1888	Edward R. Demain. ....	4,970
Hartford, Conn. ....	A, B. ....	.....	1904	William W. Neifert. ....	6,330
Hatteras, N. C. ....	A, E. ....	.....	1874	Frank H. Ahearn. ....	2,280
Havre, Mont. ....	A. ....	.....	1892	Charles W. Ling. ....	2,050
Helena, Mont. (section center). ....	A, C, D. ....	Reclamation Service, Forest Service. ....	1880	William T. Lathrop. ....	9,650
Honolulu, Hawaii (section center). ....	A, C, D. ....	Hawaii Experiment Station. ....	1904	L. H. Daingerfield. ....	7,550
Houghton, Mich. ....	A. ....	.....	1900	Howard B. Cowdrick. ....	3,530
Houston, Tex. (section center). ....	A, B, C, D. ....	.....	1909	Bernard Bunnemeyer. ....	18,840
Huron, S. Dak. (section center). ....	A, C, D. ....	.....	1881	Montello E. Blystone. ....	7,540
Indianapolis, Ind. (section center). ....	A, B, C, D. ....	.....	1871	John H. Armington. ....	14,700
Iola, Kans. ....	A, B, C. ....	.....	1905	M. Wright. ....	2,180
Independence, Cal. ....	A, C. ....	.....	1894	Wayland Bailey. ....	2,250
Ithaca, N. Y. (section center). ....	A, C, D. ....	New York Experiment Station, Cornell University, and Randall School. ....	1887	Wilford M. Wilson. ....	6,900
Jacksonville, Fla. (section center). ....	A, C, D. ....	.....	1871	Alexander J. Mitchell. ....	15,200
Juneau, Alaska (section center). ....	A, C. ....	.....	1916	Melvin B. Summers. ....	10,550
Kalispell, Mont. ....	A. ....	.....	1899	John Grover. ....	2,190
Kansas City, Mo. ....	A, B, C, D. ....	.....	1888	Patrick Connor. ....	13,200
Keokuk, Iowa. ....	A, B. ....	.....	1871	Frederick C. Gosewisch. ....	2,460
Key West, Fla. ....	A, E. ....	.....	1870	Harry B. Boyer. ....	8,160
Knoxville, Tenn. ....	A, B. ....	.....	1871	John F. Voorhees. ....	5,900
La Crosse, Wis. ....	A, B. ....	.....	1872	Edwin C. Thompson. ....	4,860
Lander, Wyo. ....	A. ....	.....	1891	McLin S. Collom. ....	1,820
Lansing, Mich. ....	A. ....	.....	1910	Dewey A. Seeley. ....	5,180
Leesburg, Ga. ....	A, G. ....	War Department. ....	1918	F. T. Cole. ....	12,000
Lewiston, Idaho. ....	A. ....	.....	1900	Walter W. Thomas. ....	2,900
Lexington, Ky. ....	A. ....	.....	1893	William A. Mitchell. ....	3,930
Lincoln, Nebr. (section center). ....	A, C, D, H. ....	University of Nebraska. ....	1897	George A. Loveland. ....	10,250
Little Rock, Ark. (section center). ....	A, B, C, D. ....	.....	1879.	Harvey S. Cole. ....	11,300
Los Angeles, Cal. ....	A, D. ....	.....	1877	Ford A. Carpenter. ....	11,700
Louisville, Ky. (section center). ....	A, B, C, D. ....	.....	1871	Ferdinand J. Walz. ....	16,700
Ludington, Mich. ....	A. ....	.....	1912	Cyrus H. Eshleman. ....	3,100
Lynchburg, Va. ....	A. ....	.....	1871	George N. Wilson. ....	3,500
Macon, Ga. ....	A, B. ....	.....	1899	Richard M. Geddings. ....	4,250

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*Distribution of work and expenditures by stations—Continued.*

Location.	Character of work. <sup>1</sup>	Cooperation.	Date begun.	Assignment.	Proposed expenditures, 1918-19.
Madison, Wis.....	A, H.....	University of Wisconsin.	1904	Eric R. Miller.....	\$4,800
Marquette, Mich.....	A.....		1871	Henry R. Patrick.....	3,600
Memphis, Tenn.....	A, B, C, D.....		1871	Samuel C. Emery.....	8,480
Meridian, Miss.....	A, B, D.....		1889	James H. Jaqua.....	4,830
Miami, Fla.....	A.....		1911	Richard W. Gray.....	3,100
Milwaukee, Wis. (section center).	A, C, D.....		1870	William P. Stewart...	12,000
Minneapolis, Minn. (section center).	A, B, C, D.....		1890	Ulysses G. Pursell....	14,300
Mobile, Ala.....	A, B, C, D.....		1870	Albert Ashenberger...	8,000
Modena, Utah.....	A.....		1901	Harry M. Hightman...	1,650
Montgomery, Ala. (section center).	A, B, C, D.....		1872	Patrick H. Smyth.....	7,850
Mount Weather, Va.....			1904	James E. Fowler.....	1,900
Nantucket, Mass.....	A.....		1896	George E. Grimes.....	2,300
Narragansett Pier, R. I.	A, E.....		1882	Margaret E. Conway...	1,600
Nashville, Tenn. (section center).	A, B, C, D.....		1870	Roscoe Nunn.....	12,470
New Haven, Conn.....	A.....	Yale University.....	1872	Leonard M. Tarr.....	8,200
New Orleans, La. (district forecast and section center).	A, B, C, D.....		1870	I. M. Cline.....	30,100
New York, N. Y.....	A.....		1870	James H. Scarr.....	30,800
Norfolk, Va.....	A.....		1871	William G. Burns.....	11,120
Northfield, Vt.....	A.....		1887	William A. Shaw.....	3,620
North Head, Wash.....	A, E, F.....		1902	Walter F. Feldwisch...	3,100
North Platte, Nebr.....	A.....		1874	Alphonso W. Shilling...	3,150
Oklahoma, Okla. (section center).	A, B, C, D.....		1890	J. P. Slaughter.....	12,720
Omaha, Nebr.....	A, B, C, D.....		1870	Lucius A. Welsh.....	9,120
Oswego, N. Y.....	A.....		1870	Julius G. Linsley.....	2,350
Palestine, Tex.....	A.....		1881	Louis Dorman.....	2,860
Parkersburg, W. Va. (section center).	A, B, C, D.....		1881	Henry C. Howe.....	6,820
Pensacola, Fla.....	A.....		1879	G. S. Lindgren.....	6,100
Peoria, Ill.....	A.....		1905	Merton L. Fuller.....	5,520
Philadelphia, Pa. (section center).	A, B, C, D.....		1871	George S. Bliss.....	16,230
Phoenix, Ariz. (section center).	A, B, C, D.....	Forest Service.....	1895	Robert Q. Grant.....	9,730
Pierre, S. Dak.....	A.....		1891	Herman T. Collman...	1,800
Pittsburgh, Pa.....	A, B.....		1870	Henry Pennywitt.....	15,760
Pocatello, Idaho.....	A.....		1899	Arthur R. Teeple.....	1,600
Port Angeles, Wash.....	A, E, F.....		1898	Leon G. Sutton.....	13,200
Port Arthur, Tex.....	A.....		1916	William H. Hossler...	2,300
Port Huron, Mich.....	A.....		1874	R. C. West.....	2,950
Portland, Me.....	A, B.....		1871	Edward P. Jones.....	5,150
Portland, Oreg. (district forecast and section center).	A, B, C, D.....	Forest Service.....	1871	Edward L. Wells.....	32,000
Providence, R. I.....	A.....		1904	Charles S. Wood.....	6,360
Pueblo, Colo.....	A, D.....		1888	W. D. Fuller.....	3,670
Raleigh, N. C. (section center).	A, B, C, D.....		1884	Lee A. Denson.....	12,970
Rapid City, S. Dak.....	A.....		1888	Harley N. Johnson.....	2,260
Reading, Pa.....	A.....		1912	Cornelius J. Doherty...	4,820
Red Bluff, Cal.....	A.....		1877	Hermann J. Andree...	2,090
Reno, Nev. (section center).	A, C, D.....	Forest Service.....	1905	H. F. Alps.....	8,890
Richmond, Va. (section center).	A, B, C, D.....		1897	Edward A. Evans.....	8,850
Rochester, N. Y.....	A.....		1870	Luther M. Dey.....	5,450
Roseburg, Oreg.....	A.....		1877	William Bell.....	3,080
Roswell, N. Mex.....	A, D.....		1904	Cleve Hallenbeck.....	1,730
Royal Center, Ind.....	A, G.....	War Department.....	1918	H. W. Ball.....	12,000
Sacramento, Cal.....	A, B.....		1877	Nathaniel R. Taylor...	6,650
Saginaw, Mich.....	A, B.....	Arthur Hill Trade School.	1912	Frank H. Coleman....	4,300
St. Joseph, Mo.....	A.....		1910	William S. Belden.....	5,450
St. Louis, Mo.....	A, B, C, D.....	St. Louis University..	1870	Montrose W. Hayes...	25,000
St. Paul, Minn.....	A.....		1870	John N. Ryker.....	4,240
Salt Lake City, Utah (section center).	A, B, C, D.....	Forest Service, Reclamation Service.	1874	J. C. Alter.....	12,500

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*Distribution of work and expenditures by stations—Continued.*

Location.	Character of work. <sup>1</sup>	Cooperation.	Date begun.	Assignment.	Proposed expenditures, 1918-19.
San Antonio, Tex.....	A, D.....	.....	1885	Allen Buell.....	\$5,750
San Diego, Cal.....	A.....	.....	1871	Henry F. Alciatore.....	5,120
Sandusky, Ohio.....	A.....	.....	1877	Claude C. Cooper.....	5,000
Sandy Hook, N. J.....	A.....	.....	1914	W. H. Tracy.....	3,530
San Francisco, Cal. (district forecast and section center).	A, C, D, E....	Forest Service.....	1871	Edward A. Beals.....	40,000
San Jose, Cal.....	A.....	.....	1905	Maurice Connell.....	2,000
San Juan, P. R., W. I. (section center).	A, C, D.....	Navy Department....	1893	F. E. Hartwell.....	4,050
San Luis Obispo, Cal..	A.....	.....	1894	J. E. Hissong.....	1,970
Santa Fe, N. Mex. (section center).	A, C, D, H...	Forest Service.....	1871	Charles E. Linney....	6,350
Sault Ste. Marie, Mich.	A.....	.....	1877	Alexander G. Burns..	4,140
Savannah, Ga.....	A, C, D.....	.....	1871	Charles M. Strong....	8,800
Scranton, Pa.....	A.....	.....	1900	William M. Dudley....	4,750
Seattle, Wash. (section center).	A, C, D.....	Forest Service.....	1893	George N. Salisbury...	15,940
Sheridan, Wyo.....	A.....	.....	1907	Harry A. Frise.....	2,670
Shreveport, La.....	A, B, D.....	.....	1871	James W. Cronk.....	4,680
Sioux City, Iowa.....	A, B.....	.....	1889	Gilbert W. McDowall..	4,620
Spokane, Wash.....	A.....	.....	1881	Charles Stewart.....	5,230
Springfield Ill. (sec- tion center).	A, C, D.....	.....	1879	Clarence J. Root.....	8,980
Springfield, Mo.....	A.....	.....	1887	Walter B. Hare.....	3,920
Syracuse, N. Y.....	A.....	.....	1902	Morgan R. Sanford....	4,920
Tacoma, Wash.....	A.....	.....	1897	Louis C. Cover.....	4,520
Tampa, Fla.....	A.....	.....	1890	Walter J. Bennett....	4,670
Tatoosh Island, Wash.	A, E, F.....	.....	1902	Ralph C. Mize.....	3,480
Taylor, Tex.....	A, D.....	.....	1901	J. P. McAuliffe.....	3,580
Terre Haute, Ind.....	A, B.....	.....	1912	William R. Cade.....	6,420
Thomasville, Ga.....	A.....	.....	1905	Maurice C. Faulk.....	2,050
Toledo, Ohio.....	A.....	.....	1870	William S. Currier....	5,850
Tonopah, Nev.....	A.....	.....	1906	C. D. Asher.....	2,680
Topeka, Kans. (section center).	A, B, C, D....	.....	1887	S. D. Flora.....	5,500
Trenton, N. J. (section center).	A, C, D.....	.....	1913	G. H. Noyes.....	8,770
Valentine, Nebr.....	A.....	.....	1885	C. Dexter Grunow....	1,830
Vicksburg, Miss. (sec- tion center).	A, B, C, D....	.....	1871	Robert T. Lindley....	8,950
Wagon Wheel Gap, Colo.	A, C.....	Forest Service.....	1910	J. H. Jarboe.....	5,270
Walla Walla, Wash....	A, D.....	.....	1885	Charles C. Garrett....	3,420
Washington, D. C. (central office of the bureau and district forecast center).	A, B, C, D, E, G, H, K, L.	Government of Can- ada, Smithsonian Institution, Alaska Agricultural Experi- ment Station.	1870	Charles F. Marvin.C.C. Clark, and others.	437,505
Wausau, Wis.....	A, B.....	.....	1915	H. E. Hyre.....	2,350
Wichita, Kans.....	A, B, D.....	.....	1888	Samuel P. Peterson...	5,780
Williston, N. Dak.....	A.....	.....	1893	John Craig.....	1,800
Wilmington, N. C.....	A, C, D.....	.....	1871	George W. Felger.....	4,900
Winnemucca, Nev.....	A.....	.....	1884	Ray L. Fisher.....	2,010
Wytheville, Va.....	A.....	.....	1902	James I. Widmeyer....	1,960
Yankton, S. Dak.....	A.....	.....	1873	William H. Fallon....	1,800
Yellowstone Park, Wyo	A.....	.....	1903	G. E. Lawton.....	3,000
Yuma, Ariz.....	A.....	.....	1875	Sunner Hackett.....	1,840
West Indian and Car- ibbean Sea stations.	A, C.....	.....	1898	14 observers.....	30,000
Total, Weather Bureau.	.....	.....	.....	.....	1,912,930

<sup>1</sup> The letters in this column have the following meaning: A, meteorological observations and reports and daily weather forecasts; B, river and flood work; C, climatological work; D, agricultural meteorological work; E, maintenance of seacoast telegraph line in connection with forecasts and warnings and vessels reporting; F, vessel reporting; G, aerological investigations; H, solar-radiation investigations; K, general administration and supervision of work of the bureau.



ALLOTMENT OF WEATHER BUREAU APPROPRIATIONS BY PROJECTS.

Projects.	Statu- tory sal- aries.	General expenses.			
		Central office ex- penses.	Printing office.	Station salaries.	Special observa- tions and reports.
Administration:					
General administration.....	\$46,600	\$33,090			
Service:					
Forecasts and warnings.....	222,350	32,000	\$6,245	\$296,000	\$43,340
River and flood work.....	7,800	6,700	1,500	65,000	47,500
Climatological work.....	31,750	13,000	2,950	240,500	12,000
Agricultural meteorology.....	2,000	3,800	1,600	18,300	26,000
Vessel reporting.....	5,950			3,450	
Research:					
Improvement of instrumental equipment.....	1,000	500			
Investigation of the problem of forecasting.....	100	3,200		200	
River and flood investigations.....	1,200	1,000		1,400	
Investigations in climatology.....	1,400	2,000	40	2,500	
Investigations of the relation between climate and weather and crop development.....	1,400	460	50	5,600	
Aerological investigations.....	5,000	6,000	100	33,050	1,000
Solar radiation investigations.....	1,200	4,000	50	2,000	
Evaporation investigations.....		200	40	4,000	100
Meteorological investigations.....	600	1,600	75		
Seismological investigations.....	600	1,200	30	500	
Ice-storm and sheet investigations.....			50		
Investigations of frost-protection methods.....		500	50		100
Investigations in volcanology.....			20		
Total.....	323,950	109,250	12,800	672,500	130,040

Projects.	General expenses.				Total.
	Tele- graphing and tele- phoning.	Miscella- neous sta- tion ex- penses.	Travel- ing ex- penses.	Total.	
Administration:					
General administration.....				\$33,090	\$79,690
Service:					
Forecasts and warnings.....	\$250,000	\$135,800	\$14,000	777,385	999,735
River and flood work.....	23,500	31,200	3,250	178,650	186,450
Climatological work.....	800	93,810	6,000	369,060	400,810
Agricultural meteorology.....	21,450	12,200	1,600	84,950	86,950
Vessel reporting.....		2,300	50	5,800	11,750
Research:					
Improvement of instrumental equipment.....				500	1,500
Investigation of the problems of forecasting.....			50	3,450	3,550
River and flood investigations.....		50	200	2,650	3,850
Investigations in climatology.....		50		4,590	5,990
Investigations of the relation between climate and weather and crop development.....			50	6,160	7,560
Aerological investigations.....		59,030	500	99,740	104,740
Solar radiation investigations.....		240	250	6,540	7,740
Evaporation investigations.....		175	50	4,565	4,565
Meteorological investigations.....				1,675	2,275
Seismological investigations.....		25		1,755	2,355
Ice-storm and sheet investigations.....		200		250	250
Investigations of frost-protection methods.....				650	650
Investigations in volcanology.....		2,500		2,520	2,520
Total.....	295,750	337,640	26,000	1,583,930	1,912,930

## BUREAU OF ANIMAL INDUSTRY.

### GENERAL ADMINISTRATION.

#### General Administration:

*Object.*—Supervision of the bureau activities and the performance of such duties as are common to the bureau as a whole, the cost of which can not be readily prorated against the various projects involved, such as accounting and editorial work, the distribution of supplies, and matters relating to the personnel.

*Location.*—Washington, D. C.

*Date begun.*—1884.

*Assignment.*—J. R. Mohler, C. C. Carroll.

*Proposed expenditures, 1918-19.*—\$145,156, including \$118,470 statutory (regulation, \$128,000; research, \$11,370; extension, \$5,786).

### ERADICATION AND CONTROL OF ANIMAL DISEASES.

#### Supervision:

*Object.*—To supervise all work connected with the eradication and control of animal diseases and prevent the interstate spread of the contagion of these diseases; to perform duties connected with the general work of eradication, including correspondence with the public and conferences with other branches of the Government service.

*Location.*—Washington, D. C.

*Date begun.*—1884.

*Assignment.*—M. Dorset, J. S. Buckley, R. W. Hickman, A. W. Miller.

*Proposed expenditures, 1918-19.*—\$11,660 (regulation).

#### [Regulation.]

#### Eradication of Scabies in Sheep:

*Object.*—To cooperate with States in which scabies in sheep exists by providing quarantine or other measures to prevent its spread and by demonstrating proper treatment, including the cleaning and disinfection of cars, pens, and other premises, thereby fostering the industry and encouraging greater production of mutton and wool.

*Procedure.*—Inspection of animals in the areas where scabies exists and dipping of diseased or exposed animals under State or Federal supervision.

*Cooperation.*—Live-stock sanitary organizations in Arizona, California, Colorado, Idaho, Kansas, Kentucky, Louisiana, Missouri, Montana, Nebraska, Nevada, New Mexico, Oregon, Oklahoma, South Dakota, Tennessee, Texas, Utah, Washington, and Wyoming.

*Location.*—States mentioned under "Cooperation."

*Date begun.*—1903.

*Results.*—Territory released from quarantine for scabies, 1,729,016 square miles, leaving 56,284 square miles still under Federal quarantine for this purpose. During the fiscal year 1917 there were 18,645,071 sheep inspected and 5,539,919 sheep dipped for scabies. Sheep scabies now exists to a limited degree, and its complete elimination can be accomplished by the closest possible cooperation between bureau employees inspecting sheep at market centers with those assigned to field duty and with live-stock sanitary officials in eradicating the disease from limited localities where it is found to exist.

*Probable date of completion.*—1922.

*Assignment.*—A. W. Miller.

*Proposed expenditures, 1918-19.*—\$125,140.



**Eradication of Mange (Scabies) in Cattle and Horses:**

*Object.*—To eradicate scabies in cattle and horses by providing quarantine measures to prevent its spread and by demonstrating proper treatment, including the cleaning and disinfection of cars, pens, and other premises, thereby fostering the horse industry and increasing the production of beef and dairy products.

*Procedure.*—Inspection of animals in the areas where scabies exists and dipping diseased or exposed animals under State or Federal supervision.

*Cooperation.*—Live-stock sanitary organizations in Colorado, Idaho, Kansas, Missouri, Montana, Nebraska, New Mexico, Oklahoma, Oregon, South Dakota, Texas, and Wyoming.

*Location.*—States named under "Cooperation."

*Date begun.*—1905.

*Results.*—All the territory still remaining under quarantine for cattle scabies was released on April 15, 1918, the total area released since the beginning of the quarantine being 1,269,844 square miles. During the fiscal year 1917 there were 1,924,970 cattle inspected for scabies and 343,517 dipped. In order that scabies in cattle and horses may be completely eliminated from the country, it is of the utmost importance that the Federal Government continue to maintain at market centers very close inspection of all cattle and horses and report promptly to the department employees in the field and State live-stock sanitary officials any case of the disease found, to the end that local centers of infection may be promptly located and diseased animals properly treated under State or Federal supervision.

*Probable date of completion.*—1922.

*Assignment.*—A. W. Miller.

*Proposed expenditures, 1918-19.*—\$62,000.

**Supervision of Interstate Transportation of Live Stock and Inspection of Southern Cattle outside the Quarantine Area:**

*Object.*—To make a careful examination and inspection of all live stock unloaded at market centers and public stockyards where Federal inspection is maintained, to determine the presence in any of the animals of communicable diseases which might be transmitted to animals in other States; also to issue certificates covering interstate movement of animals free from disease or which have been treated under bureau supervision.

*Cooperation.*—Live-stock sanitary officials of the various States.

*Location.*—Sixty-four cities, more or less, at various points throughout the United States.

*Date begun.*—1884.

*Results.*—During the fiscal year 1917, 19,368,277 sheep were inspected and 973,272 dipped and 18,069,218 cattle inspected and 20,963 dipped, in order that they might be continued in interstate transit. During the same year there were cleaned and disinfected under bureau supervision 61,798 live-stock cars or cars which had contained live stock affected with or exposed to contagious diseases.

*Assignment.*—A. W. Miller, A. E. Wright, A. J. Raub.

*Proposed expenditures, 1918-19.*—\$152,100.

**Enforcement of the 28-Hour Law:**

*Object.*—To ascertain whether animals being shipped interstate have been unloaded for feeding, resting, and watering at such periods as are required by law; also to ascertain whether the animals have been handled in a humane manner at stockyards where such unloading is performed.

*Procedure.*—Bureau employees stationed at market or stockyard centers or feeding points en route are required to examine waybills issued by transportation companies, for the purpose of ascertaining by notations made thereon when and at what points the animals were unloaded en route for the purpose of feed, rest, and water, and to report the facts to the bureau.

*Cooperation.*—Department of Justice, Office of Solicitor of this department, and various transportation companies and shippers of live stock.

*Location.*—United States.

*Date begun.*—1906.



*Results.*—During the fiscal year 1917 there were submitted to the Department of Justice 1,829 cases of alleged violations of the 28-hour law. The penalties imposed in the cases decided in favor of the Government amounted to \$37,948.08. The enforcement of this law has resulted in securing better facilities for the feeding, watering, and handling of live stock in transit.

*Assignment.*—A. W. Miller, A. J. Raub.

*Proposed expenditures, 1918-19.*—\$34,340.

**(Inspection Relative to Existence of Contagious Diseases:** Discontinued as a separate project; included under "Supervision of Interstate Transportation of Live Stock and Inspection of Southern Cattle outside the Quarantine Area.")

**(Inspection and Tuberculin Testing of Cattle and Mallein Testing of Horses:** Discontinued as a separate project; work continued under "Inspection and Mallein Testing of Horses for Interstate Movement" and "Investigation, Treatment, and Eradication of Animal Tuberculosis.")

**Inspection and Mallein Testing of Horses for Interstate Movement:**

*Object.*—To prevent the spread of glanders in horses and mules through interstate movement.

*Procedure.*—On request of transportation company or shipper at the stockyards of a station where bureau inspection is maintained in other classes of work, veterinarians are detailed to inspect and test horses, mules, and asses with mallein, and, if found free from disease, to issue interstate certificates therefor in compliance with the laws of the State to which destined. Animals found to be diseased with glanders are required to be disposed of in accordance with the laws of the State in which the disease is discovered.

*Cooperation.*—Work is conducted in accordance with the laws and regulations of the State to which interstate shipments of animals are destined.

*Location.*—For interstate movement, at 47 cities, more or less, throughout the United States at which veterinary inspectors are stationed.

*Date begun.*—1907.

*Results.*—For interstate movement, 30,555 horses and mules were inspected during the fiscal year 1917, of which number 9,574 were tested with mallein.

*Assignment.*—A. W. Miller, A. E. Wright.

*Proposed expenditures, 1918-19.*—\$7,000.

**(Preparation and Distribution of Tuberculin, Mallein, and Blackleg Vaccine:** Superseded by "Preparation and Distribution of Mallein and Blackleg Vaccine" and "Preparation and Distribution of Tuberculin.")

**Preparation and Distribution of Mallein and Blackleg Vaccine:**

*Object.*—To furnish supplies of mallein for testing horses for glanders, and to supply blackleg vaccine for use in preventing blackleg in cattle.

*Procedure.*—Mallein and blackleg vaccine are manufactured in the laboratories at Washington and are furnished free of cost to Federal, State, county, and municipal officials. In distributing these preparations it is understood that the mallein is to be used only in making official tests and that reports of the results obtained are to be made to the Bureau of Animal Industry.

*Location.*—Washington, D. C.

*Date begun.*—1894.

*Results.*—During the fiscal year 1917, 395,455 doses of mallein and approximately 4,500,000 doses of blackleg vaccine were manufactured and distributed.

*Assignment.*—M. Dorset, J. S. Buckley, C. B. Breininger.

*Proposed expenditures, 1918-19.*—\$15,092.

**Preparation and Distribution of Field-Test Outfits for Dipping Baths:**

*Object.*—To insure that the dipping baths employed in the eradication of scabies in sheep and scabies in cattle are used at safe and effective strengths.

*Procedure.*—Federal and State officials are provided with portable outfits and necessary reagents to enable rapid and sufficiently accurate determination of the strengths of lime-sulphur baths and of nicotin baths to be made directly at the dipping vat.



*Location.*—Outfits and supplies are prepared at Washington and shipped wherever needed.

*Assignment.*—R. M. Chapin.

*Results.*—Since the inception of the work in 1914 supplies have been sent out sufficient to make about 52,000 tests. The use of only tested baths for dipping has unquestionably expedited eradication of the diseases, minimized injury to animals, and stimulated the confidence of stockmen in the ultimate success of eradication measures.

*Proposed expenditures, 1918-19.*—\$1,500.

#### [Research.]

### Investigation and Chemical Testing of Dips and Disinfectants:

*Object.*—To insure the employment of properly compounded preparations in official dipping and disinfecting operations.

*Procedure.*—Chemical investigations are made of dips and disinfectants, of methods of compounding them, and of methods of chemical analysis appropriate for accurate laboratory investigations and field tests.

*Location.*—Washington, D. C., although samples are collected from various points in the field as particular investigations require.

*Date begun.*—1907.

*Results.*—Dips and disinfectants have been standardized, new formulas developed, new methods for laboratory analysis and field test devised, and a number of papers published on the subjects under investigation.

*Assignment.*—R. M. Chapin.

*Proposed expenditures, 1918-19.*—\$3,450.

**Total, Eradication and Control of Animal Diseases, \$412,282, including \$23,480 statutory (regulation, \$410,332; research, \$3,450).**

(See also Supplement—Emergency Activities, p. 551.)

## INSPECTION AND QUARANTINE OF IMPORTED ANIMALS, AND EXPORT LIVE-STOCK INSPECTION.

### Supervision:

*Object.*—Supervision of the work of inspection and quarantine of imported animals, of export live-stock inspection, the sanitary handling and control of hides and other animal by-products, hay, straw, forage, or similar material offered for entry into the United States, and the performance of duties common to the whole work.

*Cooperation.*—Treasury Department, Department of State, and organizations of tanners.

*Location.*—Washington, D. C.

*Date begun.*—1884.

*Assignment.*—R. W. Hickman.

*Proposed expenditures, 1918-19.*—\$10,600 (regulation).

#### [Regulation.]

### Inspection of Animals for Importation:

*Object.*—To prohibit the importation of diseased animals through inspection at ports of entry and the establishment of quarantine when necessary.

*Procedure.*—When presented for entry at Canadian or Mexican border ports animals are inspected by bureau inspectors and rejected, quarantined, or passed, according to circumstances. Animals permitted importation from countries other than those of North America are inspected on the vessel before landing, and those requiring quarantine, under the regulations, are transferred to quarantine stations for observation. Upon request of prospective importers bureau inspectors in Great Britain apply tuberculin tests to cattle intended for shipment to the United States.

*Cooperation.*—Collectors of customs at ports of entry and American consuls in foreign countries.

*Location.*—Ports of entry for import animals along the Mexican border, in Arizona, California, and Texas; the Canadian border in Maine, Vermont, New York, Michigan, North Dakota, Montana, and Washington; and for animals from other than North American countries, ports of entry in Massachusetts, New York, Maryland, Florida, California, and Washington. Upon application of importers cattle in Great Britain are tuberculin tested before shipment to this country by an inspector stationed in England.

*Date begun.*—1884.

*Results.*—During the fiscal year 1917, 574,303 animals were inspected. Of this number 6,552 were quarantined. The tuberculin test was applied to 1,498 cattle in Great Britain for importation into the United States and to 597 head during the quarantine period in this country.

*Assignment.*—R. W. Hickman.

*Proposed expenditures, 1918-19.*—\$69,180.

### **Quarantine of Animals at Ports of Entry:**

*Object.*—To prohibit the importation of diseased animals.

*Procedure.*—Animal quarantine stations are provided by the department and equipped with buildings and facilities for detention and isolation of live stock. Ruminants and swine and collie and shepherd dogs are held under supervision, as provided by regulations, and during the period of quarantine are carefully observed and subjected to blood or other tests, as deemed necessary.

*Location.*—Turner (Baltimore), Md.; Athenia (New York), N. J.; and Littleton (Boston), Mass.

*Date begun.*—1884.

*Results.*—During the fiscal year 1917 the volume of shipments from Great Britain was in excess of that for the previous year. There were quarantined at the port of New York 1,518 cattle, 30 sheep, 4 swine, and 90 other animals, and at the port of Boston 277 cattle and 376 sheep. During the same period 456 sheep from New Zealand were quarantined at San Francisco, also 502 other animals, including dogs.

*Assignment.*—R. W. Hickman.

*Proposed expenditures, 1918-19.*—\$13,200.

### **Supervision over the Sanitary Handling and Control of Hides, Skins, Other Animal By-Products, Hay, etc., Offered for Entry into the United States:**

*Object.*—To prevent the introduction of animal diseases.

*Procedure.*—Inspectors at ports of entry, in cooperation with customs officials, prevent the landing of prohibited feedstuffs, animal by-products, etc., and supervise disinfection as required. Certain forms of certificates are required to accompany hides, skins, hair, wool, etc., from various countries, or, if such materials are not duly certified, they are permitted shipment to a factory or tannery having proper facilities and there disinfected under bureau supervision.

*Cooperation.*—In this work there is more or less cooperation with collectors of customs at ports of entry and American consuls in foreign countries, also with proprietors or officials of various tanneries at which hides and skins are disinfected or with factories and mills where hair and wool are treated.

*Location.*—Various ports of entry where bureau inspection is maintained.

*Date begun.*—1890.

*Results.*—There have been no instances of the introduction of infection through such products over which the bureau has maintained supervision.

*Assignment.*—R. W. Hickman.

*Proposed expenditures, 1918-19.*—\$22,000.

### **Inspection and Testing of Animals for Export to Foreign Countries:**

*Object.*—To insure freedom of export animals from disease.

*Procedure.*—Animals are inspected and tested as required by countries to which exported and reinspected at ports of export and certificates issued.

*Cooperation.*—Canadian Government.

*Location.*—Various bureau stations and other places as may be required.

*Date begun.*—1890.



*Results.*—During the fiscal year 1917 there were 3,076 animals inspected prior to shipment, not including 339,166 horses and mules, a large proportion of which were exported to Europe for Army purposes, subject to inspection by officials of the countries to which consigned. Mallein tests were applied to 9,802 horses and mules prior to shipment, and 2,272 cattle for export were tuberculin tested.

*Assignment.*—R. W. Hickman.

*Proposed expenditures, 1918-19.*—\$7,300.

### Inspection of Vessels Carrying Export Animals:

*Object.*—To provide for the safe transportation and humane treatment of export live stock.

*Procedure.*—Vessels are surveyed and construction of fittings supervised to conform to department regulations; loading is supervised.

*Cooperation.*—Collectors of customs at ports of shipment.

*Location.*—Vessels are inspected at ports of export in Maine, Massachusetts, New York, Pennsylvania, Maryland, Virginia, South Carolina, Louisiana, Texas, California, and Washington.

*Date begun.*—1891.

*Results.*—During the fiscal year 1917, 705 vessels carrying live stock were inspected, and 168 certificates were issued to accompany export animals.

*Assignment.*—R. W. Hickman.

*Proposed expenditures, 1918-19.*—\$2,700.

### [Research.]

### Investigation of Methods of Disinfecting Hides:

*Object.*—To determine the best methods for the disinfection of hides, in order to prevent the introduction of infectious material.

*Procedure.*—Bacteriological and chemical studies are made of the effect of disinfectants on disease-producing microorganisms on hides, and studies are made of the effect of disinfectants applied to hides and skins upon the quality of leather produced.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Results.*—The effectiveness of the Seymour-Jones and Schattenfroh methods has been determined and the results published in the Journal of Agricultural Research, vol. 4, No. 1. Regulations governing disinfection of hides were changed in 1917. (Joint Order No. 2 and B. A. I. Order 256.)

*Assignment.*—F. W. Tilley, R. M. Chapin.

*Proposed expenditures, 1918-19.*—\$3,500.

**Total, Inspection and Quarantine of Imported Animals, and Export Live-Stock Inspection, \$128,480, including \$13,620 statutory (regulation, \$124,980; research, \$3,500).**

## INVESTIGATION, TREATMENT, AND ERADICATION OF ANIMAL TUBERCULOSIS.

### Supervision:

*Object.*—To direct and coordinate all research and control work relating to the cause and prevention of animal tuberculosis.

*Location.*—Washington, D. C.

*Date begun.*—1918.

*Assignment.*—J. A. Kiernan, M. Dorset, E. C. Schroeder, H. J. Washburn.

*Proposed expenditures, 1918-19.*—\$12,000 (regulation, \$7,000; research, \$5,000).

### [Regulation.]

### Animal Tuberculosis Control Looking to Eradication:

*Object.*—The extermination of tuberculosis in cattle and swine.

*Procedure.*—The presence of tuberculosis is determined by the tuberculin test, assisted by physical examination of the animals. Tuberculous animals will be slaughtered or isolated from healthy animals, and infected premises will be disinfected. In States in which cooperative arrangements are made owners of tuberculous cattle will be indemnified one-third of the difference between the appraised value of the animals and the amount for which they are salvaged.

*Cooperation.*—Live-stock sanitary organizations in Utah, Idaho, Virginia, North Carolina, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, Minnesota, Montana, North Dakota, South Dakota, Indiana, Ohio, Michigan, Wisconsin, Kentucky, Oregon, Washington, District of Columbia, South Carolina, Georgia, Alabama, Tennessee, Mississippi, and other States to be determined later.

*Location.*—States mentioned under "Cooperation" and other States when satisfactory arrangements have been made with them.

*Date begun.*—1918.

*Assignment.*—J. A. Kiernan, A. E. Wight.

*Proposed expenditures, 1918-19.*—\$456,100.

#### **Preparation and Distribution of Tuberculin:**

*Object.*—To furnish and supply tuberculin for testing cattle for tuberculosis.

*Procedure.*—Tuberculin is manufactured in the laboratories at Washington and furnished upon request of the Tuberculosis Eradication Division to inspectors engaged in tuberculosis-eradication work and also to State, county, and municipal officials, upon the condition that the tuberculin thus furnished is to be used only in making official tests and that reports of the results obtained are to be made to the Bureau of Animal Industry.

*Location.*—Washington, D. C.

*Date begun.*—1892.

*Results.*—During the fiscal year 1917, 1,201,404 cubic centimeters of tuberculin were prepared and distributed.

*Assignment.*—M. Dorset.

*Proposed expenditures, 1918-19.*—\$30,000.

#### **[Research.]**

#### **Investigation of Animal Tuberculosis:**

*Object.*—To gain further information about the causes responsible for the dissemination of tubercle bacilli and the propagation of tuberculosis among cattle, hogs, and other domestic animals; to determine the results following single exposure and long-continued and uninterrupted exposure; to determine whether tubercle bacilli are commonly or at any time sufficiently numerous in the circulating blood of tuberculous animals to make them a factor requiring special consideration relative to the use of products from such animals as food; to prove whether it is possible to keep tuberculous and healthy cattle on small areas without the transmission of the disease; to find some method for the treatment of tuberculosis; to devise preventive means; to test the reliability of commercial tuberculin; to determine the frequency with which dairy products are infected with tubercle bacilli; to study Johne's disease and its cause, as well as other acid-fast bacilli; to develop a simple, safe, and economical method for disinfecting stables and pens which have been occupied by tuberculous animals; and to discover the most economical means for the eradication of bovine tuberculosis and Johne's disease and the gradual conversion of a tuberculous into a healthy herd of cattle.

*Location.*—Bureau experiment station at Bethesda, Md.

*Date begun.*—1884.

*Results.*—It has been found that some species of animals are capable of harboring tubercle bacilli in their tissues for long periods of time without developing lesions of tuberculosis; that feces from tuberculous cattle are the most dangerous tuberculous material to which hogs are exposed under natural conditions, and that tuberculosis among brood sows does not seem to be a serious menace to their progeny if other exposure to infection is eliminated; that tubercle bacilli occur in the circulating blood of animals affected with advanced, more or less generalized, tuberculosis but not in the blood of tuberculous animals which have retained the appearance of health; that very little separation and relatively simple and inexpensive precautions are required to prevent the transmission of tuberculosis from affected to healthy herds; that all methods of treatment so far tested have proved unsatisfactory; that, though there is some variation in the strength of different brands of tuberculin, samples which fall below a reasonable standard of potency are very rare; that butter from time to time contains virulent tubercle



bacilli but much more frequently acid-fast germs microscopically like tubercle bacilli but incapable of causing tuberculosis in test animals; that virulent tubercle bacilli are of fairly common occurrence in some brands of soft, fresh cheese but do not seem to occur in cheese which requires some time to ripen; that the thorough cleansing of stables infected with tuberculosis followed by a coat of whitewash is all that is required to make them safe for healthy animals; and that very few calves born in a tuberculous environment contract tuberculosis if left in such an environment until they are weaned and then removed.

*Assignment.*—E. C. Schroeder, H. J. Washburn, W. E. Cotton, G. W. Brett.  
*Proposed expenditures, 1918-19.*—\$15,200.

**Total, Investigation, Treatment, and Eradication of Animal Tuberculosis,** \$513,300, including \$13,300 statutory (regulation, \$493,100; research, \$20,200).

[Regulation.]

## ERADICATION OF CATTLE TICKS.

### Tick Eradication:

*Object.*—The extermination of the ticks which spread the infection of splenic fever of cattle.

*Procedure.*—Instruction and demonstration work is carried on, followed by the systematic dipping of cattle in arsenical solution to prevent the propagation of ticks, or by the total removal of cattle from pastures for a time, to the end that ticks may not find a host on which to develop.

*Cooperation.*—State live-stock sanitary organizations in Alabama, Arkansas, California, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

*Location.*—States mentioned under "Cooperation."

*Date begun.*—1906.

*Results.*—Since tick eradication was commenced, in July, 1906, there has been freed from ticks and released from quarantine an area of 379,312 square miles, or approximately 52 per cent of the 728,565 square miles under quarantine in 1906. As a result of the beneficial effects received by farmers from their efforts to eradicate ticks, the work is now advancing rapidly in every State under quarantine. Liberal State and county appropriations are being made, and the work is advancing much more rapidly than it did during the early stages of tick eradication. This is evidenced by the fact that during the calendar year 1917 there were 21,449 dipping vats in operation, and ticks were eradicated from an area of 70,754 square miles and the Federal quarantine removed, permitting the cattle from this large area to move interstate without restrictions, and also permitting the entry, into this region, of well-bred beef and dairy cattle for the improvement of the cattle industry of the Southern States.

*Probable date of completion.*—1924.

*Assignment.*—R. A. Ramsay, W. P. Ellenberger.

*Proposed expenditures, 1918-19.*—\$712,700.

(See also Supplement—Emergency Activities, p. 551.)

### Preparation and Distribution of Field-Test Outfits for Dipping Baths:

*Object.*—To insure that arsenical dipping baths for eradicating cattle ticks are used at the proper strength.

*Procedure.*—Federal and cooperating State officials are provided with portable outfits and necessary reagents for making rapid and sufficiently accurate determination of the strength of arsenical baths directly at the dipping vat.

*Location.*—Outfits and supplies are prepared at Washington and shipped wherever needed.

*Results.*—Supplies are now being sent out at the rate of 600,000 tests a year. The use of only tested baths for dipping has unquestionably greatly expedited the progress of eradication, minimized injury to cattle, and stimulated the confidence of cattle owners in the measures adopted for eradication and its final success.

*Assignment.*—R. M. Chapin.

*Proposed expenditures, 1918-19.*—\$20,000.

**Total, Eradication of Cattle Ticks,** \$732,700, including \$32,700 statutory.



## [Extension.]

**LIVE-STOCK DEMONSTRATION WORK IN AREAS FREED FROM CATTLE TICKS.****Live-Stock Demonstration Work in Tick-Freed Areas:**

*Object.*—To demonstrate to farmers the best means within their reach to improve and develop the live-stock industry in areas freed from cattle ticks in the Southern States.

*Procedure.*—Live-stock associations are organized for the purpose of providing ways and means of introducing better live stock and developing better pastures and forage crops in order that live stock may be properly cared for. One or more employees experienced in animal husbandry and the dairy industry are assigned to each State, their duty being to cooperate with the agents in the employ of the States Relations Service and with State employees doing the same class of work. Bureau veterinarians engaged in tick eradication are instructed to cooperate with these different forces in the inspection and tuberculin testing of live stock, to the end that disease may not be introduced into tick-freed areas.

*Cooperation.*—States Relations Service and the extension divisions of agricultural colleges of the States mentioned under "Location."

*Location.*—Counties and localities which have been freed from ticks in Louisiana, Arkansas, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Oklahoma, and Texas.

*Date begun.*—1914.

*Results.*—During the fiscal year 1918 the specialists have devoted their time and attention to carrying out the war program in their respective States as pertaining to beef cattle by stressing the importance of growing more feed crops, conserving grains, utilizing roughages in cattle-feeding operations, planting permanent pastures, and the construction of silos. In round numbers, 150,000 head of cattle, mostly cows, were brought into the Southern States from the drought section of the Southwest. These cattle are being carefully watched by the specialists, who are emphasizing to the farmers their proper care. In addition to the emergency work, the bringing in of pure-bred cattle, organization of live-stock associations, forage-crop demonstrations, and cattle-feeding demonstrations have been carried on to a greater extent than during the previous year.

Twelve dairy specialists are at work in the tick-freed areas. In the past year three bull associations have been organized, through which 135 farmers have been enabled to obtain the services of 12 meritorious pure-bred dairy bulls in improving the progeny of 568 cows. Assistance was given the introduction and purchase of 84 pure-bred dairy bulls and 42 pure-bred and 515 high-grade cows and heifers for farmers in that territory. Eleven cream routes were organized, 5 of which were cooperative. Cream grading and demonstration work among the patrons resulted in the construction of 6 water heaters, 2 washing vats, 8 cream cooling tanks, and 3 separators. Assistance has been given 46 farmers in the keeping of herd records and in placing their dairying on a profitable basis. Dairyemen have been assisted in building 40 silos. Twelve farmers were given assistance in the construction of calf stanchions, 45 in the building and remodeling of barns, and 4 in the construction of milk houses. Ninety-eight demonstrations in butter making, to improve the quality of country butter, have been given, and as a result many farmers have purchased barrel churns, thermometers, etc.

*Assignment.*—B. H. Rawl, G. M. Rommel, and F. W. Farley, of this bureau; Bradford Knapp and employees of the States Relations Service in charge of field forces in the Southern States.

*Proposed expenditures, 1918-19.*—\$50,000.

**DAIRY INVESTIGATIONS.****ADMINISTRATION.****Administration:**

*Object.*—General supervision of the Dairy Division work, including branch library, files, requisitions and accounts, dairy engineering, compilation and indexing, editorial and stenographic work, and stores.

*Location.*—Washington, D. C.



*Date begun.*—1895.

*Assignment.*—B. H. Rawl.

*Proposed expenditures, 1918-19.*—\$47,422, including \$17,500 statutory (research, \$21,950; extension, \$24,172; regulation, \$1,300).

#### DAIRY FARMING AND EXTENSION.

##### Supervision:

*Object.*—General supervision and office correspondence and record work; compilation of material for use in field work and preparation of manuscripts.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Assignment.*—Helmer Rabild.

*Proposed expenditures, 1918-19.*—\$11,940 (research, \$2,400; extension \$9,540).

[Extension.]

##### Southern Dairying:

*Object.*—To encourage the development of the dairy business by instruction and demonstration.

*Procedure.*—Farmers are instructed in the feeding of dairy cows, the raising of calves, and the construction of silos and dairy buildings. Herd records are introduced and advice given in the selection of pure-bred bulls. An endeavor is made to improve the quality of dairy products. Work is taken up with rural schools and creamery extension work done in cooperation with the dairy-manufacturing section.

*Cooperation.*—Extension departments of the colleges of agriculture in the States named under "Location."

*Location.*—North Carolina, South Carolina, Georgia, Alabama, Tennessee, Mississippi, Louisiana, Arkansas, Oklahoma, and Texas.

*Date begun.*—1905.

*Results.*—During the past year eight cow-testing associations were organized, with a membership of 129 farmers, and 28,055 cows brought under test in these associations. Five bull associations were organized and were the means of introducing 24 pure-bred bulls into one State. Assistance was given the introduction and purchase of 237 pure-bred bulls, 387 pure-bred cows, and 1,144 grade dairy cattle into the Southern States. Fifty-two farmers were given assistance in the construction of calf stanchions, 169 in the construction and remodeling of barns, and 65 in the construction of milk houses. One hundred and seventy silos were also built for dairymen. As a result of assistance given 123 farmers in the keeping of herd records of 1,716 cows, 131 unprofitable ones were found and sold. Yearbook Separate 744, "How the Dairy Cow Brought Prosperity in the Wake of the Boll Weevil," showing some results of work in Mississippi, was published.

*Assignment.*—J. H. McClain.

*Proposed expenditures, 1918-19.*—\$18,300.

##### Dairy Demonstration Farm:

*Object.*—To demonstrate the practicability of reclaiming a worn-out cotton farm by dairying.

*Procedure.*—A pure-bred bull is used in the dairy herd, records are kept of the production of each cow, and heifer calves from only the best cows are retained in the herd. Home-grown roughage is used as far as possible. Crop rotations are established, suitable buildings maintained, and permanent pastures established.

*Cooperation.*—Denison Board of Trade.

*Location.*—Denison, Tex.

*Date begun.*—1907.

*Results.*—At the beginning of the project a demonstration herd was started with scrub cows, which has been improved year by year through breeding and selection. In 1917 the milk production per cow was 10.2 per cent higher than in 1916. Most of the product is now sold as market milk, for which there is a fair demand in Denison. The dairy herd, including the young stock, consists of 52 head, and all are of a very uniform type. The herd is free from tuberculosis, and by constant attention on the part of the manager the farm has been kept practically free from the cattle tick. Through the application of manure from the dairy herd the



fertility of the farm is constantly increasing. The statement of the income and expenses for the past year, together with the inventories, is quite encouraging and indicates that the work is meeting with considerable success.

*Assignment.*—A. M. Goodman.

*Proposed expenditures, 1918-19.*—\$2,160.

### **Cow-Testing Associations and Cooperation with County Agents in Dairy Work:**

*Object.*—To increase economically the average milk and butter production of the dairy cows in the United States, and to assist county agents with general dairy work, such as silo and dairy building construction, feeding, care, and management of dairy cattle, special assistance at fairs, etc.

*Procedure.*—A campaign is conducted to investigate the general profitability of dairy herds, to eliminate the unprofitable cows, and to build up the herds by the use of pure-bred bulls and by the selection of females. Cooperative cow-testing associations are organized and advice and assistance given in their supervision. Where the State can be interested in this work, the supervision of the associations is placed under the extension department of the State agricultural colleges. Upon request, advice and assistance are to be given county agents along different lines of dairy work. A dairy specialist joins the county agent for a week or two to help start special lines of dairy work. The county agent is usually not trained in dairying, but with a little assistance occasionally from one so trained the work may be conducted on broad constructive lines. The specialist assists him in the construction of silos, dairy barns, and dairy houses, in the organization of cow-testing and other dairy associations, and in dairy campaigns of all kinds.

*Cooperation.*—States Relations Service and State agricultural colleges; project agreements are entered into with the extension departments of the agricultural colleges of the States in which the work is done.

*Location.*—Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, Pennsylvania, New Jersey, Maryland, West Virginia, Ohio, Indiana, Kansas, Michigan, Wisconsin, Iowa, Minnesota, and Nebraska.

*Date begun.*—Cow-testing association work was begun in 1908, and county-agent cooperation in 1914.

*Results.*—459 cow-testing associations have been organized and records kept of 11,720 herds, comprising 211,966 cows. In some associations the profits have doubled in four years, and the records indicate that an increased profit of \$10 a cow over the previous year is not exceptional. Feeds adapted to the needs of the cows have been selected without increasing the cost of the ration. The work introduces business systems of record keeping on the dairy farm and fosters cooperation. B. A. I. Circular 79, "Cow-Testing Associations," and publications from a number of States cooperating have been issued.

*Assignment.*—Helmer Rabild.

*Proposed expenditures, 1918-19.*—\$31,320.

### **Extension of Bull Associations:**

*Object.*—To inaugurate a Nation-wide campaign in the interest of the joint ownership of pure-bred dairy bulls of merit.

*Procedure.*—Men are employed to assist in the organization of bull associations throughout the country, with a view to the joint ownership of meritorious pure-bred dairy bulls by the members of the associations. Each association is made up of a certain number of blocks, or individual neighborhoods, in which cows enough are owned to require the services of one bull. Every two years the bulls are shifted from one block to another.

*Cooperation.*—Extension departments of the colleges of agriculture in the States in which the work will be performed and the States Relations Service.

*Location.*—Throughout the United States.

*Date begun.*—1917.

*Results.*—During the past year 12 bull associations were organized and supervision given to 24 others. These associations have made it possible for 1,174 farmers to obtain the use of meritorious pure-bred bulls for service to 8,521 cows. In one association a bull increased the production of each of his 6 daughters over their dams by 93.8 pounds of butter fat and 1,695 pounds of milk, while another bull in the same association increased the production of 5 daughters by 55.8 pounds of butter fat and



1,004 pounds of milk. The work is described in detail in Yearbook Separate 718, "Cooperative Bull Associations."

*Assignment.*—J. G. Winkjer.

*Proposed expenditures, 1918-19.*—\$11,900.

[Research.]

### Community Development in Dairying:

*Object.*—To determine the practicability of the small community raising its economic status through the employment of a field instructor skilled in dairying.

*Procedure.*—One man works among the patrons of the creamery making a survey of the status of the dairy operations of the farms, the number of cows kept, the feeding, care, average production, net returns, etc. With these data as a basis, he endeavors to introduce constructive methods of improving the economic status of dairy farming in that community through the disposal of unprofitable cows and breeding the best animals to pure-bred dairy bulls and by instruction in proper crop rotations, the feeding of the herd, etc. He assists in the construction of silos and other dairy buildings and gives lectures at farmers' meetings. If possible, cow-testing associations, bull associations, and junior cow-testing clubs will be organized. Advice and instruction are given concerning the care of milk and cream on the farm and its delivery to the creamery in the best possible condition.

*Location.*—Grove City, Pa.

*Date begun.*—1910.

*Results.*—During the past year one cow-testing association, with 36 members, was organized and was the means of placing 430 cows on test. Two bull associations, with a membership of 51, were formed, having 7 meritorious pure-bred bulls. Supervision and assistance was given the purchase of 34 pure-bred bulls and 193 pure-bred females, which resulted in the starting of 95 pure-bred herds. Assistance was also given in constructing 18 silos, 9 milk houses, and 8 barns, and in the remodeling of 47 others.

*Assignment.*—R. R. Welch.

*Proposed expenditures, 1918-19.*—\$2,620.

### Investigations of Cow-Testing Associations:

*Object.*—To determine the best form of cooperation for the development and increase in production of the dairy herds of the United States.

*Procedure.*—A study is made of the methods of the most successful cow-testing associations in order that the best methods of each may become available to all. Summaries of production and other factors are compiled and studied to bring out any features that can be put into successful operation. An educational course for cow testers has been worked out and uniform blanks prepared which are now in general use in the various States. It is also the intention to work out a simple cost-accounting system for the dairy farm which may be introduced through cooperation with cow-testing associations.

*Location.*—Throughout the United States.

*Date begun.*—1908.

*Results.*—Partial tabulations have been made of the records from 50 cow-testing associations in different sections of the country comprising the records from over 15,000 cows. These associations show an average annual yield of 250 pounds of butter fat per cow and an average income over cost of feed of \$47. This yield, which is more than 50 per cent above the average for the United States, shows the results that have come from the keeping of records, the careful selection of individual cows, and the use of improved methods of feeding. A tabulation of the records of 40 cow-testing associations shows a gain of 62 per cent in income over cost of feed, the production of butter fat increasing from 150 to 200 pounds. As butter-fat production increased from 150 to 300 pounds, there was a gain of 300 per cent in income over cost of feed. The results of this tabulation are given in Yearbook Separate 743. Studies on the influence of date of freshening, the relation between the butter-fat test and production, influence of size within the breed, influence of the feeding of silage and legumes on income over cost of feed, etc., are also in progress.

*Assignment.*—Helmer Rabild, J. C. McDowell.

*Proposed expenditures, 1918-19.*—\$9,970.



**Investigations of Bull Associations:**

*Object.*—To determine the best form of cooperation and organization for the development of bull associations.

*Procedure.*—Studies are made of the active and defunct bull associations to ascertain the causes of failures and to determine the best form of cooperation and organization. An effort is made to organize a small number of associations in different but representative sections of the country for the purpose of studying the adaptation of this work to different localities. Records of the animals are kept to determine the relative merits of various bulls and strains of cattle in the improvement of the production of herds.

*Location.*—Throughout the United States.

*Date begun.*—1914.

*Results.*—A survey has been made of active and defunct associations. Faulty organization and lack of assistance and supervision have been the cause of most failures. Special attention was given 5 bull associations, having 141 members and using 27 meritorious pure-bred bulls on 887 cows. In one association of 16 farmers, organized into 5 blocks, it was possible to purchase meritorious bulls at an average price of \$240. The individual members invested \$75 in the association and had the use of a pure-bred bull with which to build up their herds. Before the organization of the association the members had an average investment of \$89 in scrub bulls.

One association bull increased the production of his 6 daughters over that of their dams 39 pounds of butter fat and 712 pounds of milk. Of the 17 daughters of the bulls in one association 16 excelled their dams in butter-fat production. On an average the daughters produced 1,145 pounds more milk than their dams and 63 pounds, or 26.7 per cent, more butter fat.

*Assignment.*—J. G. Winkjer.

*Proposed expenditures, 1918-19.*—\$3,600.

**(Holstein Cattle Breeding:** Project completed June 30, 1917; preliminary report of results published in North Dakota Agricultural Experiment Station Bulletin 109; later results tabulated and to be published by the North Dakota station.)

**Total, Dairy Farming and Extension,** \$91,810, including \$7,600 statutory (research, \$18,590; extension, \$73,220).

**DAIRY MANUFACTURING.****Supervision:**

*Object.*—General supervision of all work in dairy manufacturing, including extension work carried on with creameries through correspondence; compilation of information collected.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Assignment.*—S. C. Thompson, William White.

*Proposed expenditures, 1918-19.*—\$12,060 (research, \$3,060; extension, \$7,300; regulation, \$1,700).

[Extension.]

**Creamery Extension:**

*Object.*—To improve the quality of milk and cream delivered to creameries, the quality of the product, and the general efficiency of creameries.

*Procedure.*—Through personal visits, correspondence, circular letters, and a system of creamery reports advice is given in regard to establishing, building, equipping, operating, and managing creameries, and to creamery patrons advice concerning the production and handling of milk and cream, the breeding, feeding, and managing of dairy cattle, the erection of silos and dairy buildings, and the keeping of herd records.

*Cooperation.*—Extension departments of the Vermont, Texas, South Dakota, North Dakota, Wisconsin, Minnesota, Iowa, North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Tennessee agricultural colleges.

*Location.*—United States.

*Date begun.*—1908.



*Results.*—Many new creameries have been located and built in accordance with advice and plans from this division. Efficiency in creamery operations has been improved, as indicated by a material increase in the overrun obtained. Accounting systems have been improved. At certain creameries the quality of cream received has been greatly improved by the employment of a cream-grading system. This increased the financial returns to the creamery and to the patrons. The expense of operation has been decreased in several creameries by installing exhaust-steam water heaters and by improvement in the operation of the boilers and engines. Silos, dairy buildings, and ice houses have been erected under the supervision of field men, herds improved through purchase and breeding, herd records kept, production increased through better herd management, and the dairy industry generally benefited in those localities to which special attention has been given.

*Assignment.*—William White, M. P. A. Sondergaard, W. L. Clevenger, L. S. Edwards, V. R. Jones, C. E. Newlander, H. H. Whiting, F. L. Odell.

*Proposed expenditures, 1918-19.*—\$20,335.

### Cheese Factory Extension:

*Object.*—To encourage the building of cheese factories in localities where the industry will prove successful; to improve the quality of milk delivered to cheese factories; to improve the methods of making, and hence the quality of, cheese; and to increase the general efficiency of cheese factories and their management.

*Procedure.*—Personal visits are made to sections that have been found suitable for cheese making and the establishment of cheese factories recommended. Assistance is given in building and equipping cheese factories and in training cheese makers. Information is given cheese-factory patrons regarding the care of milk and the operation of the dairy.

*Cooperation.*—Extension divisions of the agricultural colleges in the States named under "Location."

*Location.*—Virginia, North Carolina, South Carolina, Tennessee, Georgia, Idaho, Montana, Washington, Oregon, and Wyoming.

*Date begun.*—1914.

*Results.*—Thirty cheese factories have been organized in the mountainous sections of the Southeastern States and are being successfully operated. Marked improvement has been made at several factories in the East in the efficiency of operation and the quality of the cheese.

*Assignment.*—W. W. Fisk, C. M. Gere, H. S. Merry, F. R. Farnham, D. R. Noland, C. N. Tobey, R. R. Hogue, L. H. Marlatt, E. L. Chaplin, H. A. Chaplin, W. F. Gerholz.

*Proposed expenditures, 1918-19.*—\$10,430.

(Farm Butter Making: Discontinued as a separate project; included under "Improvement of Dairy Products.")

### [Research.]

### Creamery Management Investigations:

*Object.*—To study methods of improving the quality of milk and cream delivered to creameries and the quality of creamery butter, and to increase the general efficiency of creameries.

*Procedure.*—Through personal visits, correspondence, and personal supervision of certain creameries data are gathered showing the conditions under which milk and cream are handled on the farm, at cream buying stations, and at the creamery, the effect of a cream grading system upon the quality of cream delivered, the fuel cost of creameries, and the cost of the different operations in the manufacture of butter.

*Location.*—Washington, D. C., Grove City, Pa., and creameries throughout the United States.

*Date begun.*—1906.

*Results.*—Information has been gathered showing the conditions under which dairy products are handled from the production of the milk to the marketing of the butter. The effect of the use of a cream grading system under certain conditions has been determined. Data have been

gathered showing the cost of fuel and of different operations in the manufacture of butter. Publications issued: B. A. I. Circular 126, "A Simple Method of Keeping Creamery Records"; and B. A. I. Bulletins—148, "The Manufacture of Butter for Storage," and 149, "The Normal Composition of American Creamery Butter."

*Assignment.*—S. C. Thompson, M. P. A. Sondergaard, J. C. Joslin.

*Proposed expenditures, 1918-19.*—\$8,100.

#### **Cheese Factory Investigations:**

*Object.*—To determine in what districts it would be feasible to encourage the manufacture of cheese, what is being done in the manufacture of cheese in districts other than the cheese centers, and particularly what kinds of cheese can be successfully and profitably manufactured in certain sections of the South; to secure data relative to methods used in the best managed factories; and to determine what machinery is most efficient for cheese factories.

*Procedure.*—Data are secured from reports by cheese factories in different sections of the country. Representatives visit localities where cheese might be produced and endeavor to stimulate an interest in this industry. Studies are being made of equipment and methods of operating cheese factories.

*Location.*—United States.

*Date begun.*—1915.

*Results.*—Data have been gathered on the cost of making cheese, and the cheese making possibilities of the mountainous sections of the South and of the Rocky Mountain States have been studied.

*Assignment.*—C. M. Gere, E. L. Chaplin.

*Proposed expenditures, 1918-19.*—\$3,500.

#### **[Regulation.]**

#### **Renovated-Butter Inspection:**

*Object.*—To carry on the inspection of renovated butter, the materials used in its manufacture, and the factories producing this product, as required by the act of May 9, 1902.

*Procedure.*—At the plants where the inspection is done by Bureau of Animal Industry lay inspectors both the factory and the products are inspected frequently. Where no such inspectors are stationed about three inspections are made each month. The chief inspector has general supervision of the inspection. The work is done according to regulations issued jointly by the Secretary of the Treasury and the Secretary of Agriculture under dates of July 11, 1907, September 30, 1908, and October 23, 1911 (B. A. I. Order 147, amendments 1 and 2 thereto and supplement to amendment 1, and B. A. I. Order 193).

*Location.*—United States.

*Date begun.*—1902.

*Results.*—Factories are inspected at intervals by two regular renovated-butter inspectors and about 20 bureau lay inspectors. A sanitary condition of the factories and product is maintained. Compliance with the regulations regarding the marking of renovated-butter packages is required.

*Assignment.*—T. Corneliuson, Chris Johnsen.

*Proposed expenditures, 1918-19.*—\$6,400.

#### **Butter Inspection for Navy Department:**

*Object.*—To assist the Navy Department in securing first-class tinned and tub creamery butter and to study the manufacture of butter for storage.

*Procedure.*—Inspectors are stationed at the plants where butter for storage is packed for the Navy. These inspectors daily ascertain that both the raw material and the finished product comply with the requirements of the specifications. One man has general supervision of this work at all the plants.

*Cooperation.*—The Navy Department bears the expenses of the special inspector and furnishes samples of butter for examination and analysis.

*Location.*—At creameries throughout the United States having contracts for Navy butter.

*Date begun.*—1902.



*Results.*—A marked improvement in the quality of the butter over that produced in former years has been obtained. Sweet cream is churned and the deterioration in quality is small. Nearly 1,000,000 pounds were inspected annually until last year, when the quantity was 3,000,000 pounds.

*Assignment.*—T. Corneliuison.

*Proposed expenditures, 1918-19.*—\$1,000.

**Total, Dairy Manufacturing, \$61,825, including \$2,100 statutory (research, \$14,660; extension, \$38,065; regulation, \$9,100).**

[Research.]

**DAIRY RESEARCH LABORATORIES.**

**Supervision:**

*Object.*—General supervision and office work of the dairy research laboratories.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Assignment.*—L. A. Rogers.

*Proposed expenditures, 1918-19.*—\$6,380.

**Investigations of the Manufacture and Handling of Commercial Ice Cream:**

*Object.*—To determine methods and conditions necessary for the practical, economical, and sanitary manufacture of ice cream.

*Procedure.*—The bacteriology of the raw materials entering into the product and the influence of these bacteria on the flavor and their value as an indication of insanitary conditions are studied. Studies are also made of the use of pure cultures in developing desirable flavors and of the influence of various constituents on the flavor and physical characters of the product, ice cream being manufactured on a laboratory scale to facilitate the investigation. The practical application of the principles thus established is determined by work on a commercial scale.

*Cooperation.*—Private individuals who manufacture ice cream.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Results.*—The numbers and kinds of bacteria which may be expected in commercial ice cream and the influence on the flavor of a number of the usual constituents of ice cream have been determined. A comparison has been made of different methods of storing butter fat and of the replacement of a part of the cane sugar by other sugars. Publications: Department Bulletins 303 and 563.

*Assignment.*—O. E. Williams, S. H. Ayers.

*Proposed expenditures, 1918-19.*—\$3,640.

**(Changes in Butter: Discontinued as a separate project; included under "Butter and Dairy By-Products Investigations.")**

**Butter and Dairy By-Products Investigations:**

*Object.*—To determine the factors which control the flavor, both desirable and undesirable, of butter, including a study of methods of handling cream, pasteurization, ripening of cream, changes of butter in storage, and methods of renovating; and to study methods for the utilization of by-products of creameries and cheese factories by converting them into products which will be useful in the arts or available as food for man or animals.

*Procedure.*—Studies are made of (1) the bacterial flora of cream under different conditions, the bacteria and yeasts of butter under normal conditions and as affected by different factors, such as the temperature and time of storage and the addition of antiseptics, and the relation of microorganisms to change in flavor; (2) the chemical changes in butter, the factors which control them, and the relation of these changes to the changes in flavor of butter; and (3) the effect of various creamery practices on the flavor of butter and on the nature of the changes in storage.

Chemical studies are made of dairy by-products and of the products into which they may possibly be converted. This includes investigations of new products and methods of manufacture. At the experimental creamery skimmed milk is condensed by various methods for ice-cream makers, bakers, and confectioners or converted into casein, milk sugar,



albumen, etc. Attempts are made to convert whey from cheese or casein manufacture into milk sugar or a flour for cooking purposes. When the practicability of a method has been established it will be applied on a commercial scale in order to determine the cost of production and the profits of manufacture.

*Location.*—Washington, D. C., and Grove City, Pa.

*Date begun.*—1902.

*Results.*—It has been found that bacteria are not a factor in the ordinary deterioration of butter. Factors increasing the rate of change are high acidity of cream, presence of metal salts, increased acid in butter, and high storage temperature. The principal cause of change in flavor is an oxidation of the nitrogenous constituents, in which nearly all the oxygen of the air inclosed in the butter is consumed. By eliminating many of these factors it is possible to make butter of exceptional keeping quality.

An investigation of the manufacture of casein has shown that the qualities of buttermilk casein which make it inferior to skimmed-milk casein for paper making are its higher ash and fat content. A method of manufacture has been devised by which these faults can be corrected and a casein obtained which is nearly equal to skimmed-milk casein.

Details for the successful manufacture of cottage cheese from skimmed milk and buttermilk under creamery conditions have been worked out and the results published.

Publications issued: B. A. I. Bulletins 57, 84, 89, 114, 148, 149, and 162, B. A. I. Circulars 100, 130, 146, 189, and 200, Department Bulletins 661 and 576, Farmers' Bulletin 850, and three papers in scientific journals.

*Assignment.*—A. O. Dahlberg, H. S. Garner, L. A. Rogers, C. L. McArthur.  
*Proposed expenditures, 1918-19.*—\$11,500.

(See also Supplement—Emergency Activities, p. 553.)

### **Milk Condensing Investigations:**

*Object.*—To secure a general knowledge of milk condensing; to determine causes of spoilage and develop logical methods of operation.

*Procedure.*—Chemical and bacteriological studies of normal and abnormal milk and condensing experiments on a small scale are made. All new methods will be tested on a commercial scale in the experimental creamery.

*Location.*—Washington, D. C., and Grove City, Pa.

*Date begun.*—1914.

*Results.*—A survey of the methods of condensing in this country has been made and equipment installed for condensing on a laboratory and a commercial scale. Progress has been made in determining the amount of sugar necessary to prevent bacterial growth in condensed milk. The nature and cause of the so-called "buttons" has been established, and some of the factors controlling the thickening of milk have been worked out.

*Assignment.*—L. A. Rogers, E. F. Dysher, F. R. Evans, C. L. McArthur.  
*Proposed expenditures, 1918-19.*—\$5,900.

### **Bacteriology of Milk:**

*Object.*—To acquire complete and detailed knowledge of the bacteria occurring in milk, their relation to one another and to similar groups occurring elsewhere, their physiology and action on the constituents of milk, their habitat and the means by which they get into milk, and methods of preventing contamination and destroying bacteria in milk.

*Procedure.*—Biological studies are made of particular groups, as, for instance, the morphology, temperature limitations, food requirements, and natural habitat of the group of bacteria giving an alkaline reaction in milk. Similar studies are made on the lactic-acid bacteria, the colon group, the bacteria inhabiting the udder of the cow, and other types of bacteria. The groups of bacteria established by these studies are compared with similar bacteria found under natural conditions, and the means by which they are transmitted from their natural habitat to milk are traced. Facilities for this work are available at the Beltsville farm. Methods of destroying bacteria in milk are determined by laboratory studies of pasteurization, action of ultra-violet rays, etc. This includes a study of the bacteria surviving pasteurization, the limits of heat which may be used as determined by changes in the milk, and the most efficient methods of pasteurization. From time to time work on a commercial scale is conducted in city milk plants.



*Location.*—Washington, D. C., and Beltsville, Md.

*Date begun.*—1905.

*Results.*—Much exact information has been obtained on the biology of various groups of bacteria, particularly the colon group, the streptococci, and the alkali-forming group, their relative numbers in milk, and their origin. The bacteriological and chemical changes which occur when milk is pasteurized have been determined and a new and efficient method of pasteurization established.

The relative importance of various factors in the bacterial contamination of milk has been determined. A simple and inexpensive sterilizer for dairy utensils on the farm has been devised. A study has been made of the bacterial flora of the udder with special reference to the bacillus of contagious abortion. Data are given in B. A. I. Bulletins 73, 126, 154, 161, and 166, Department Bulletins 240, 342, and 420, and 13 papers published in scientific journals.

*Assignment.*—S. H. Ayers, Philip Rupp, P. W. Clemmer, W. T. Johnson, jr.  
*Proposed expenditures, 1918-19.*—\$7,740.

### **Physiology of Milk Secretion and Nutrition of Dairy Cows:**

*Object.*—To obtain definite knowledge of the mechanism of milk secretion and of the factors which control or influence this function, with a view to a more logical breeding and feeding of dairy cows.

*Procedure.*—A study is made of the changes in the blood of dairy cows, as influenced by the period of lactation, secretion of milk, plan of nutrition, and similar factors.

*Location.*—Beltsville, Md.

*Date begun.*—1915.

*Results.*—Results of previous work on a similar project are published in B. A. I. Bulletins 111, 134, 155, 156, and 157, and in papers on carotin and lactochrome.

A point has been established below which the phosphorus content of the blood can not go without a decreased milk production. Results indicate that it may be possible to maintain this phosphorus content by a more economical system of feeding than is at present practiced.

*Assignment.*—E. B. Meigs, C. A. Cary.

*Proposed expenditures, 1918-19.*—\$8,600.

**(Utilization of Creamery and Cheese Factory By-Products:** Discontinued as a separate project; included under "Butter and Dairy By-Products Investigations.")

### **Metabolism in Dairy Cows:**

*Object.*—To determine the total energy of the feed consumed by milking animals, the losses of energy in the excreta, the expenditure of energy consequent upon the consumption of the feed and, by difference, the net energy of the feed; to determine the distribution of this net energy of the feed between the two possible forms of reproduction, viz, fattening or milk secretion, and the effect upon it of the quantity and quality of the feed as well as of other factors.

*Procedure.*—(1) The maintenance requirement of the dry animals is determined. (2) A moderate ration is fed to test animals, and by means of successive respiration-calorimeter experiments the variations in the distribution of net energy between milk production and body gain with advancing lactation are traced. In this way it is hoped to determine the quantitative relation between the two forms of production. (3) The effect of varying amounts of the same combination of feeding stuffs in increasing the milk production, on the one hand, and the body gain of the animal, on the other hand, are determined. (4) Studies are made of the effect upon milk production and body gain of substituting protein for carbohydrates, and vice versa, in rations otherwise identical.

*Cooperation.*—Animal Nutrition Institute of Pennsylvania State College.

*Location.*—State College, Pa.

*Date begun.*—1915.

*Results.*—Three respiration-calorimeter experiments have been successfully carried out on three cows in milk, each receiving throughout the experimental period a ration uniform in quantity and quality. An experiment has been conducted to determine the effect upon milk production of vary-

ing amounts of the same feed mixture. The data obtained are now being compiled.

*Assignment.*—H. P. Armsby, State College, Pa.

*Proposed expenditures, 1918-19.*—\$3,650.

### **Disposal of Dairy, Creamery, and Cheese-Factory Wastes:**

*Object.*—To provide means for the proper disposal of the wastes of dairy farms, creameries, and cheese factories.

*Procedure.*—The condition of the effluent and the cost of operation of experimental sewage-disposal plants installed on the dairy farm at Beltsville, Md., and at the experimental creamery at Grove City, Pa., will be observed and modifications made as required. On the basis of the results obtained with these plants, designs will be made for sewage-disposal plants for dairy farms, creameries, and cheese factories.

*Cooperation.*—Hygienic Laboratory, Public Health Service, and Bureau of Public Roads.

*Location.*—Grove City, Pa., and Beltsville, Md.

*Date begun.*—1915.

*Results.*—An experimental sewage-disposal plant has been installed at the creamery at Grove City, Pa. The wastes from the creamery have been successfully disposed of by a combination of septic tank and sand filters. The proper sizes and rates of flow have been determined.

*Assignment.*—L. A. Rogers.

*Proposed expenditures, 1918-19.*—\$500.

**(Manufacture and Ripening of Swiss Cheese:** Discontinued as a separate project; included under "Manufacture and Ripening of Cheese.")

**(Soft-Cheese Investigations:** Discontinued as a separate project; included under "Manufacture and Ripening of Cheese.")

**(Cheddar-Cheese Investigations:** Discontinued as a separate project; included under "Manufacture and Ripening of Cheese.")

### **Manufacture and Ripening of Cheese:**

*Object.*—To acquire complete and detailed knowledge of the methods of manufacture and factors producing the peculiar flavors and physical characters of various types of cheese in order to improve the quality of domestic cheese and to make it possible to produce here the cheeses now imported from foreign countries.

*Procedure.*—Studies are made of (a) the chemical changes necessary to the production of the flavors and textures of the different varieties, (b) of the bacteria and other microorganisms concerned in these changes, and (c) of the methods of manufacture and curing-room conditions required to produce the essential flavors, texture, and appearance, and (d) commercial-scale tests of methods developed in the laboratory are conducted.

*Location.*—Washington, D. C., and Grove City, Pa.

*Date begun.*—1906.

*Results.*—In the study of Swiss cheese sufficient knowledge has been gained of the bacteria concerned in its ripening to make it possible to reproduce this type of cheese in any locality where good milk can be secured. A method has been developed for making and curing a cheese of the Roquefort type from cows' milk which compares very favorably with the imported sheep's-milk cheese. Similar results have been obtained with Camembert. It has been demonstrated that satisfactory cream and Neufchatel cheese can be made from pasteurized milk. Considerable progress has been made in determining the bacteria giving the characteristic flavor to Cheddar cheese. A factory for the manufacture on a commercial scale of Swiss, Camembert, and Roquefort will be ready for use in 1918.

Publications: B. A. I. Bulletins 62, 71, 82, 85, 98, 109, 115, 118, 120, 122, 123, 150, 151, and 165; B. A. I. Circulars 166, 181, and 210; Department Bulletin 148; Storrs (Conn.) Experiment Station Bulletins 78 and 79; and 17 papers published in scientific journals.

*Assignment.*—W. M. Clark, K. J. Matheson, J. M. Sherman, A. C. Weimar, H. F. Zoller.

*Proposed expenditures, 1918-19.*—\$14,800.



**Silage Investigations:**

*Object.*—To study the changes which take place in the material put into the silo and to investigate the possibilities of ensiling crops other than corn.

*Procedure.*—The quality of silage made from different crops at various stages of maturity, as determined by chemical and physical examination and feeding tests, is studied. Chemical studies are made of the fermentations of normal silage and of the losses due to fermentation, seepage, and other factors.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Results.*—No difference has been observed in the chemical composition or appearance of the silage from wooden or concrete silos. The loss in total weight and in food constituents has been determined in silage from the two kinds of silos. Methods of protecting concrete silos from the corroding action of acid silage juice have been perfected.

*Assignment.*—R. H. Shaw, P. A. Wright.

*Proposed expenditures, 1918-19.*—\$4,135.

(Chemical Investigations in the Feeding of Dairy Cattle: Discontinued as a separate project; included under "Physiology of Milk Secretion and Nutrition of Dairy Cows.")

**Total, Dairy Research Laboratories, \$66,845, including \$5,250 statutory.**

**MILK INVESTIGATIONS AND DEMONSTRATIONS.****Supervision:**

*Object.*—To supervise the work of the section, answer correspondence, etc.

*Location.*—Washington, D. C.

*Date begun.*—1900.

*Assignment.*—Ernest Kelly.

*Proposed expenditures, 1918-19.*—\$4,660, including \$2,160 statutory (research, \$2,400; extension, \$2,260).

**[Research.]****Dairy Sanitation Investigations:**

*Object.*—To study the sanitation of city milk supplies, investigate factors influencing the commercial quality of milk, and devise means for producing and handling milk of a superior quality.

*Procedure.*—Studies are made of farms supplying milk to cities throughout the country and of plants handling milk in the cities, with a view to discover efficient methods and equipment. A large number of milk and cream samples are studied to note the effect of various operations on the bacterial content of milk and the effect of certain feeds on the flavor of milk.

*Cooperation.*—State and municipal boards of health and dairymen.

*Location.*—United States.

*Date begun.*—1900.

*Results.*—Studies on the cooling of milk and cream, transportation of milk, and efficiency of various methods of straining milk have been completed. Work on flavors and odors in milk has been continued. Manuscripts on cooling and straining have been submitted for publication.

*Assignment.*—Ernest Kelly, G. B. Taylor, J. A. Gamble.

*Proposed expenditures, 1918-19.*—\$2,760.

**Cost of Handling Milk:**

*Object.*—To determine the cost of handling milk in cities, including the cost of various operations in preparing milk for the market; to discover uneconomical methods and suggest ways of lessening the cost of handling.

*Procedure.*—Surveys are made of milk plants in various cities to obtain the desired information. A cooperative agreement exists between this bureau and the Bureau of Markets regarding this work.

*Cooperation.*—Bureau of Markets and milk dealers.

*Location.*—United States.

*Date begun.*—1912.

*Results.*—Surveys have been made of over 100 milk plants. A large mass of data has been gathered dealing with investment, labor, organization, and various other items. The results of these investigations have been brought to the attention of milk dealers by means of circular letters. Assistance has been given to milk dealers in planning and equipping their plants, in the organization of eight cooperative milk plants, and in the construction and operation of plants supplying milk in Army cantonment zones. A study made of the Detroit milk supply is given in Department Bulletin 639. An article on "The City Milk Plant" has been prepared.

*Assignment.*—C. E. Clement, B. Vener.

*Proposed expenditures, 1918-19.*—\$5,090.

### **Milk Production:**

*Object.*—To secure data regarding milk production on the average dairy farm; to ascertain the additional expense attributable to modern sanitary methods and the variation in milk production in different sections.

*Procedure.*—Field agents are employed in several States to make observations on a group of dairy farms to secure data regarding milk production.

*Cooperation.*—North Carolina, Indiana, and Nebraska agricultural colleges.

*Location.*—North Carolina, Indiana, Vermont, Nebraska, Washington, Louisiana, and two States to be selected.

*Date begun.*—1914.

*Results.*—Tabulation of data secured for two years in Indiana and North Carolina; collection of data in other States.

*Probable date of completion.*—1921.

*Assignment.*—J. B. Bain, R. J. Posson, G. E. Braun, R. P. Hotis, C. H. Cook, W. D. Wood.

*Proposed expenditures, 1918-19.*—\$11,600.

#### **[Extension.]**

### **Dairy Sanitation Extension:**

*Object.*—To carry on educational work among dairymen and milk handlers and to unify and make more efficient inspections conducted by State and municipal boards of health.

*Procedure.*—This work is done almost exclusively in cooperation with the State and municipal boards of health. Visits are made to cities at the request of the proper authorities and inspectors instructed in an efficient system of dairy and milk inspection.

*Cooperation.*—State and municipal boards of health, U. S. Public Health Service, and State dairy commissioners.

*Location.*—United States.

*Date begun.*—1900.

*Results.*—Many city milk supplies have been greatly improved from a sanitary standpoint. A large number of health departments have inaugurated an efficient and systematic control of milk supplies. Surveys have been conducted and improvements made in the milk supply of 12 extra cantonment zones, in cooperation with U. S. Public Health Service. Publications: B. A. I. Circular 199, Department Bulletins 356 and 585, and Farmers' Bulletins 602, 689, and 748.

*Assignment.*—Ernest Kelly, G. B. Taylor, L. B. Cook, R. S. Smith, J. A. Gamble, H. N. Thomas, C. S. MacBride.

*Proposed expenditures, 1918-19.*—\$18,800.

**Total, Milk Investigations and Demonstrations, \$42,910, including \$4,060 statutory (research, \$21,850; extension, \$21,060).**

#### **[Research.]**

### **DAIRY DIVISION EXPERIMENT FARM.**

### **Supervision and Maintenance:**

*Object.*—Supervision of the dairy experiment farm and of the experimental work conducted there; maintenance of office, laboratories, dairy herd, and buildings; provision for the transportation of dairy products to Washington and for the making of necessary improvements at the farm.

*Location.*—Beltsville, Md.

*Date begun.*—1910.

*Assignment.*—T. E. Woodward, J. B. McNulty.

*Proposed expenditures, 1918-19.*—\$24,864.



(**Breeding of Dairy Cattle:** Discontinued as a project under "Dairy Division Experiment Farm" and included under the general project, "Breeding of Dairy Cattle," conducted at various points in the United States.)

### **Feeding of Dairy Cattle:**

*Object.*—To ascertain the effects of the various feeds and constituents of feeds upon the animal body, upon growth, and upon the yield and composition of milk; to find out the relative values of feeds for dairy production.

*Procedure.*—All the dairy animals on the Beltsville farm are used for experimental work. Feeds and constituents of feeds of known composition are fed selected animals in definite amounts and for stated periods. The results are measured in one or more of several ways, depending on the nature of the particular experiment, such as palatability and digestibility of the food, health, vigor, and growth of the animals, production of milk and fat, and the composition and flavor of the dairy product. Chemical analyses of the feed and the product, and in some cases of the excreta also, are required.

*Location.*—Beltsville, Md.

*Date begun.*—1913.

*Results.*—The effect of feeding calves on milk substitutes, sour milk, cold skimmed milk, cottonseed meal, and starch has been determined. The chemical composition of milk is not changed when cows are given a succulent feed, when a portion of the water normally consumed is withheld, nor when mineral matter in the form of bone meal is added to the ration. In cooperation with the market milk section, it was found that beet pulp injured the flow of the milk. This was especially noticeable when milk was allowed to stand for several days. It has been demonstrated that the flavor and odor of milk and cream are influenced decidedly by exposure to silage odors. The value of prickly pear as a feed for dairy cows has been determined and the results published in the *Journal of Agricultural Research*, vol. 4, No. 5, "Prickly Pears as a Feed for Dairy Cows." Dried fish meal, a by-product of the sardine-canning industry, although somewhat unpalatable, was found to increase the yield of milk but to cause a decrease in the percentage of fat. Potato meal and potato silage were found to be palatable.

*Assignment.*—T. E. Woodward.

*Proposed expenditures, 1918-19.*—\$1,664.

### **Housing and Care of Dairy Cattle:**

*Object.*—To investigate problems in the milking of cows and the care of dairy stock, including the best method of stabling cows.

*Procedure.*—The cattle are kept under different stabling conditions and the results measured by the milk and fat produced, economy of labor and feed, health of the animals, and sanitation of the milk. Cows are watered at different intervals and in different quantities and the results measured as above.

*Location.*—Beltsville, Md.

*Date begun.*—1912.

*Results.*—An experiment lasting three years has shown the open shed to be a successful method of housing dairy cattle. It keeps the cows clean and provides for the saving and storage of manure in a very satisfactory way. The effect of the southern cattle tick upon milk production and body weight of dairy cows has been determined and the results published in Department Bulletin 147. Cooperative work with the Dairy Division laboratories has shown that milk with low bacterial count can be produced under average farm conditions, provided ordinary care is exercised in keeping the cows and stable clean and the utensils are properly sterilized with steam. The results of this work are published in Department Bulletin 642, "Four Essential Factors in the Production of Milk of Low Bacterial Content."

*Assignment.*—J. B. McNulty.

*Proposed expenditures, 1918-19.*—\$2,626.

### **Feed Production:**

*Object.*—Primarily, to produce feed for the dairy herd. Detailed records are kept of the cost of all farm operations and observations made on the building up of the soil by fertilization, tillage, and drainage.



*Procedure.*—About 170 acres of the Dairy Division experiment farm are tillable, and all this area is devoted to the growing of crops for the dairy cattle and for the maintenance of work stock. Detailed records are kept of the cost of all operations.

*Cooperation.*—Bureaus of Soils and Public Roads.

*Location.*—Beltsville, Md.

*Date begun.*—1910.

*Results.*—The land has been cleared, ditches filled, 44,000 feet of draitile laid, the roads through the farm and around the buildings graded and surfaced, and grading done around the buildings. The productivity of the land has been greatly increased by the application of manure and lime and by a systematic rotation of crops. All the silage and most of the hay required for feeding the dairy herd and the work stock for the farm is being grown on the farm. It has been found that the land can be plowed to a depth of 8 inches with a 15-30-horsepower tractor at an average cost of \$1.12 per acre. Similar land plowed to the same depth with a walking plow and two mules was found to cost \$1.43 per acre.

*Assignment.*—T. E. Woodward.

*Proposed expenditures, 1918-19.*—\$8,888.

(**Silage Investigations:** Discontinued as a separate project under "Dairy Division Experiment Farm"; work covered by project of a similar title under "Dairy Research Laboratories.")

**Total, Dairy Division Experiment Farm, \$38,042, including \$8,000 statutory.**

[Extension.]

**WESTERN DAIRY EXTENSION.**

**Supervision:**

*Object.*—General supervision of western dairy extension work, including clerical routine, general correspondence, etc.

*Location.*—Salt Lake City, Utah.

*Date begun.*—1911.

*Assignment.*—J. E. Dorman.

*Proposed expenditures, 1918-19.*—\$6,340.

**Dairy Farming:**

*Object.*—To improve and develop the business of dairying in the Western States.

*Procedure.*—Cooperative field agents instruct farmers in feeding dairy cows, raising calves, construction of dairy buildings and silos, keeping of individual production records of cows, and selection of pure-bred bulls. Assistance is given teachers in rural schools in courses of instruction in dairy-cow record keeping, care of the dairy cow, and raising of calves. The field agents cooperate with county agents in handling their dairy problems, including the development of cow-testing associations and bull associations.

*Cooperation.*—Extension divisions of the agricultural colleges in the States named under "Location."

*Location.*—Montana, New Mexico, Nevada, Utah, Wyoming, Oregon, Washington, and Idaho.

*Date begun.*—1908.

*Results.*—Wyoming has purchased over 1,100 head of dairy cattle within the past two years, including 27 pure-bred bulls; New Mexico, 10 pure-bred bulls and 136 cows. Fifty-one cow-testing associations and two bull associations have been organized. A number of schools have conducted dairy record-keeping contests with the assistance of the bureau's field men. Assistance has been given in building 577 silos, 13 dairy barns, and 5 milk houses. Excellent cooperation has been given county agents, and the production records of 841 dairy cows are being kept, not including those in cow-testing associations.

*Assignment.*—J. E. Dorman, A. B. Pike.

*Proposed expenditures, 1918-19.*—\$19,900.

**Milk Work:**

*Object.*—To carry on educational work among dairymen and milk distributors and to unify and make more effective the inspection of milk in the cities and towns.



*Procedure.*—This work is done almost exclusively in cooperation with the State and municipal boards of health and State dairy commissions. Visits are made to cities at the request of the proper officials, and instruction is given to inspectors in important and efficient methods of inspection of dairy farms and dairy products.

*Cooperation.*—State and city boards of health and State dairy commissions.

*Location.*—Western United States.

*Date begun.*—1912.

*Results.*—Milk and cream contests have served to point out defective methods of production and handling. During the past year 24 contests were held in eight States and 1,258 samples of milk and cream examined and scored. Assistance was given during the past year to the cities of Portland, Oreg., Seattle, Everett, Tacoma, Spokane, and Yakima, Wash., Butte, Mont., Reno, Nev., Los Angeles, Cal., and Salt Lake City and Ogden, Utah. Assistance was given several cities in drafting milk ordinances. A milk and dairy inspectors' association was organized in California, the inspectors in all the cities of that State being included in its membership.

*Assignment.*—C. F. Hoyt.

*Proposed expenditures, 1918-19.*—\$3,600.

### **Dairy Manufacturing:**

*Object.*—To carry on educational work for the purpose of introducing better methods of manufacturing dairy products and to assist in securing a uniformly good product.

*Procedure.*—Assistance is given to creameries and cheese factories where needed. Assistance is also given in the organization and equipment of creameries and cheese factories where conditions are favorable for successful operation. Scoring contests are conducted, products scored and criticized, and advice given to improve quality.

*Cooperation.*—Creameries and cheese factories in the Western States.

*Location.*—Western United States.

*Date begun.*—1912.

*Results.*—In recent years a great variation in the finished products was found. The monthly State scoring contests and the annual dairy products show has very materially improved the quality of both butter and cheese. Visits to 41 creameries and 20 cheese factories were made during the past year. Eighty samples of butter and 25 of cheese were entered at the Western Dairy Products Show at Yakima, Wash., this year, which showed a decided improvement in uniformity over last year. Whey separators for saving butter fat in whey have been installed in 14 cheese factories upon the advice of field agents.

*Assignments.*—G. E. Frevert, E. L. Chaplin, H. A. Chaplin, W. F. Gerholz.

*Proposed expenditures, 1918-19.*—\$7,420.

**Total, Western Dairy Extension, \$37,260, including \$1,000 statutory.**

[Extension.]

### **IMPROVEMENT OF DAIRY PRODUCTS.**

#### **Improvement of Dairy Products:**

*Object.*—To increase the quantity and improve the quality of dairy products and to encourage a larger consumption of them on the farm.

*Procedure.*—Dairy specialists capable of making on the farm any of the ordinary farm dairy products will give demonstrations and otherwise assist State extension workers in the improvement of farm butter, cottage cheese, cream cheese, etc. The main object is to aid the State workers in acquiring the necessary knowledge to do the work alone.

*Cooperation.*—States Relations Service and extension divisions of the agricultural colleges of the States in which the work is performed.

*Location.*—Throughout the United States.

*Date begun.*—1917.

*Results.*—During the past year the making of cottage cheese has been encouraged and demonstrations given in its manufacture and in showing how it may be used in various dishes to improve and increase the home food supply. In many sections cottage cheese had not been made previous to these demonstrations. In others, where it was made, its use was

greatly restricted. Many new ways of using cottage cheese have been developed and presented at the demonstrations. Since the product has a food value equivalent to that of meat and it can be made into various palatable and nutritious dishes, its production and consumption are increasing rapidly. Assistance has also been given in the making of farm butter, cream cheese, etc. Through these demonstrations the equipment used in making these products has been improved, thus making the work easier and insuring a better product.

*Assignment.*—B. H. Rawl.

*Proposed expenditures, 1918-19.*—\$16,200, including \$1,200 statutory.

(See also Supplement—Emergency Activities, p. 553.)

#### [Research.]

### BREEDING OF DAIRY CATTLE.

#### Breeding of Dairy Cattle:

*Object.*—To study the breeding of dairy cattle and to apply such principles of breeding as are established.

*Procedure.*—The dairy herds that are being developed at the stations at Beltsville, Md., Huntley, Mont., Ardmore, S. Dak., and Iberia, La., are used for this purpose. Part of this study is made with pure-bred and part with grade cattle. The grade cattle are used for determining the practicability of inbreeding. It is proposed to arrange with a number of farmers to carry on similar breeding under the supervision of the leader of this work. The study of pure-bred cattle relates to the various systems of breeding upon productivity, vigor, prepotency, etc.

*Location.*—Beltsville, Md., Huntley, Mont., Ardmore, S. Dak., and Iberia, La.

*Date begun.*—1912.

*Results.*—Thus far the breeding work has been done with grade cattle. Twenty-three grade cows are being bred to a pure-bred bull and the female offspring bred back to their sire. Thirty-four heifers from the first mating and four from the second mating are on hand and give indication of being much better producers than their dams. Pure-bred animals especially suitable for foundation stock for experiments in inbreeding, crossing, and outcrossing have been purchased.

*Assignment.*—R. R. Graves.

*Proposed expenditures, 1918-19.*—\$8,796.

**Total, Dairy Investigations, \$411,110, including \$46,720 statutory (research, \$190,733; extension, \$209,977; regulation, \$10,400).**

### ANIMAL HUSBANDRY INVESTIGATIONS.

#### ADMINISTRATION.

#### Administration:

*Object.*—To provide for the general administration of the work of the Animal Husbandry Division. Such office expenses as are not directly chargeable to specific projects come under this head.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—Geo. M. Rommel.

*Proposed expenditures, 1918-19.*—\$12,800, including \$7,200 statutory (research, \$8,500; extension, \$4,250; regulation, \$50).

#### [Research.]

### ANIMAL GENETICS.

#### Genetic Research:

*Object.*—To obtain as complete an understanding as possible of the effects of inbreeding from a scientific standpoint; to interpret these results with regard to advantages and disadvantages in practical breeding, with suggestions as to the procedure necessary to secure the former without suffering from the latter; to obtain an understanding of the mode of inheritance of special traits; and, in general, to study the factors which determine the course of the life histories of animals.



*Procedure.*—Guinea pigs have been inbred, brother and sister, for as many as 18 generations. Matings of unrelated individuals from the same original stock are maintained as controls. Individuals of different highly inbred families are also mated in various ways to test the effects of crossing upon inbred stock. Experiments on the effects of selection within inbred lines are in progress. All these experiments deal mainly with such characters as fecundity, size, death rate, sex ratio, and coat color.

*Location.*—Washington, D. C., and Beltsville, Md.

*Results.*—(1) Prior to 1918: Work on the project was begun in June, 1906, and complete records of the experiment up to date are on file. The mere fact that the closest possible inbreeding can be carried on for at least 18 generations without any very obvious degeneration is noteworthy. Another striking result, previously reported, is the great difference between different inbred lines. Inbreeding rapidly brings about a high degree of homogeneity in a line, most conspicuous in such characters as color, but true also of the other traits under investigation. A family characterized by large size may, for example, have either large or small average litters and a high or low death rate. There has been no effort to maintain a high standard of selection, and there is no family in which only good traits have become fixed. All are inferior in some way or other to the normally bred controls, and the average of all inbred families for each character is much lower than that of the controls. This, however, appears to be a likely rather than an inevitable effect of inbreeding. Variations which are injurious are more likely to occur than beneficial ones. Thus any stock may be expected to decline unless kept up by constant selection. The selection must be especially careful during inbreeding because of the danger that injurious traits may become irrevocably fixed in the whole stock.

(2) During 1918: The most important new results in 1918 have come from a comparison of inbred stock with young from the cross of different inbred families, raised under strictly parallel conditions. Such young have shown a distinct improvement in size and vitality and have produced, on the average, larger litters than the parent families. This confirms the view that the decline in vigor brought about by inbreeding is due to the fixing of different injurious traits in different families. When two inbred lines, both of which are lacking in vigor, are crossed, each will usually supply much of what the other lacks and more vigorous offspring are the result.

*Assignment.*—Sewall Wright.

*Proposed expenditures, 1918-19.*—\$5,600, including \$540 statutory.

#### [Research.]

### ANIMAL HUSBANDRY EXPERIMENT FARM.

#### Animal Husbandry Experiment Farm:

*Object.*—To furnish facilities for investigations in the feeding and breeding of farm animals, including poultry.

*Procedure.*—The farm is managed by a superintendent under the direct supervision of the chief of division.

*Location.*—Beltsville, Md.

*Results.*—During 1917 the new sheep barn erected to take the place of the one burned in the winter of 1915-16 was practically completed, and the incubator cellar at the poultry plant is well on the way to completion.

*Assignment.*—B. F. Brandon.

*Proposed expenditures, 1918-19.*—\$21,260, including \$8,000 statutory.

### BEEF-CATTLE INVESTIGATIONS.

#### Supervision:

*Object.*—The general supervision of the work in beef-cattle investigations, correspondence, and maintenance of record files pertaining to same.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Assignment.*—F. W. Farley.

*Proposed expenditures, 1918-19.*—\$4,000 (research, \$3,500; extension, \$500).

## [Research.]

**Beef Production:**

*Object.*—To study methods of maintaining grade and pure-bred herds and of producing beef animals to various ages; to study methods of fattening cattle and the relative importance of various feedstuffs for such purpose, including work with calves, baby beeves, and steers; to study methods of wintering stocker and feeder cattle; to determine the effect of beef cattle raising on soil fertility; and to study methods of establishing permanent pastures on lands better suited for grazing than for cropping purposes.

*Procedure.*—This work is conducted, as in previous years, upon farms especially selected for the purpose and also on the Animal Husbandry farm at Beltsville, Md. The owners of the selected farms furnish all cattle, pasture lands, feed lots, sheds, and other equipment necessary for the proper conduct of the experiments, except in such cases where it is agreed that the colleges shall furnish a part of the equipment or that the bureau furnish grass seed for pasture experiments. An assistant in animal husbandry supervises and carries out the proposed experimental work. Herds of breeding animals are maintained for studying the cost of producing cattle to various ages and the economy of same. In addition to the cattle used in the breeding work, steers are secured for the stocker and feeding experiments. Complete records are kept showing the amounts of feed consumed by each lot, the weights and gains, cost of production, and all other data which may be of value in the study of these questions.

*Cooperation.*—Agricultural colleges of West Virginia, North Carolina, and Mississippi.

*Location.*—Lewisburg, W. Va., Springdale, N. C., and Collins and Canton, Miss.

*Date begun.*—1913.

*Results.*—During 1918, at Canton, Miss., 78 breeding cows are being used in the breeding experiments. Thirty-six yearlings of last year's calf crop are being carried over the summer on pasture. The promising heifers will be placed in the experimental breeding herd, while the less desirable heifers and the steers will be used in the feeding experiments next winter.

Three lots of 22 steers each were used in the feeding experiment during the winter (1917-1918) in testing the comparative value of sorghum silage and cowpea hay, sorghum silage and oat straw, and sorghum silage without other roughage. The concentrate used in each case was cotton-seed meal.

In an experiment in permanent pasture development 25 acres are being used. Fifteen acres were sown to a mixture of red top, hairy vetch, alsike clover, and meadow oats. Ten acres were sown to red top, hairy vetch, alsike clover, meadow fescue, and black medic.

At Collins, Miss., two lots of 10 steers each were used in an experiment to determine the most economical form in which to feed velvet beans to cattle. One lot was fed the velvet beans and pods ground, while the other was fed the whole velvet bean in the pod. Both lots received corn silage in addition.

Forty cows are being used in an experiment to determine the cost of producing feeders on the cut-over pine lands. Pure-bred Hereford bulls are being used with this herd, which has for its foundation the native cows of that section. A pure-bred herd of 26 cows and heifers is being kept experimentally to secure comparative data regarding the production of grade and pure-bred cattle in the cut-over pine section and to supply bulls for use on native cows. An experiment in pasture development on cut-over pine lands has been started to determine practical and economical methods of improving these lands for grazing purposes. This experiment is divided into two general phases, one involving the seeding of the land in the natural state and the second a greater or less preparation of the land for pasture purposes by the removal of stumps and underbrush before seeding the pasture crops.

The station at Collins, Miss., in the cut-over pine section was transferred from Abbott, Miss., in the black belt, July 1, 1917. The results of the three years' work at Abbott have been compiled for publication but have not yet been published. In the finishing of calves for the market it was found that at the prevailing prices of feeds in the South and South-



east the most economical gains were made with cottonseed meal alone but that corn could be used to supplement part of the cottonseed-meal ration in sections unavailable to corn markets.

At Springdale, N. C., 120 steers, divided into five lots, were used in an experiment on wintering stocker cattle to be fattened out on pasture the following summer. One lot received hay and ear corn, another corn silage, another corn silage, stover, and straw, another was carried over on well-established pastures, while the fifth lot was carried on pasture seeded last year. Records are being kept of the gains made by these lots on summer pasture. A pure-bred Shorthorn herd of 13 cows has been established in connection with the work here to determine the cost of producing pure breeds in this section for supplying bulls to grade up native herds. The wintering work is a continuation and elaboration of the three years' work compiled in Department Bulletin 628, recently released. The pure-bred work was established July 1, 1917.

At Lewisburg, W. Va., four lots of 10 steers each were used in experiments to study methods of wintering beef animals most economically on the feeds available to farmers and feeders in that section. One lot received corn silage, cottonseed meal, and wheat straw, another corn silage and soy-bean hay, another corn silage, cottonseed meal, and rye hay, and another wheat straw and mixed hay. These steers will be finished on pasture this summer. Three lots of 10 steers each were used in the experiment with reference to the wintering of calves. One lot received corn silage, cottonseed meal, and rye hay, another corn silage and clover hay, and another mixed hay and grain consisting of corn, wheat, bran, and linseed-oil meal. Thirty two-year-old native and grade cows were used in an experiment regarding the maintenance of a breeding herd for the production of feeders.

On the Animal Husbandry Division's farm at Beltsville, Md., four lots of 10 steers each are being used to compare the value of velvet beans with cottonseed meal as the sole concentrate in finishing steers and to determine the most economical form in which the beans can be fed. One lot is receiving cottonseed meal, another velvet beans and pods whole, another velvet beans and pods ground, and another velvet beans and pods soaked. All lots are receiving corn silage, corn stover, and wheat straw as roughage.

*Assignment.*—F. W. Farley, E. H. Thompson.

*Proposed expenditures, 1918-19.*—\$17,500.

### **Breeding Shorthorn Cattle:**

*Object.*—To make a study of the following points: (a) Is the milking tendency in beef cattle transmitted mainly by the dams through the male line of descent? (b) To what extent does the milk-giving function of the dam influence the beef character of the progeny? (c) By mating thickly fleshed beef bulls whose dams were heavy milkers and beef cows which transmit beef character to their progeny, is it possible to establish a heavy milking strain of beef cattle within a breed the female progeny of which will be double-purpose beef and milk animals and the males strictly of the beef type? In other words, is it possible to retain the typical beef form in the male animals and increase the milking tendency in the females? (d) Is the present standard of selecting beef cows conducive to the production of the best type in the breed?

*Procedure.*—At Manhattan, Kans., on the Agricultural College experiment farm, 20 pure-bred Shorthorn cows are kept on experiment and bred to a Shorthorn bull that is an outstanding beef animal and whose dam was a heavy milker. The calves produced are being raised by nurse cows and by hand feeding. The foundation cows are being milked and accurate records kept of their milk production and feed consumption. Heifers which prove to be good milkers will be kept to replace cows in the breeding herd. Some of the bull calves are to be castrated and used for show purposes, while others are to be sold to farmers who agree to make a trial of their breeding value and keep a careful record of their performance in this respect. Future herd bulls will be selected from the experimental breeding herd.

*Cooperation.*—Kansas Experiment Station.

*Location.*—Manhattan, Kans.

*Date begun.*—1915.

*Results.*—One outstanding bull has been retained for service in the experiment herd. Three cows have given milk enough to be eligible to registry in the record of merit of the American Shorthorn Breeders' Association. Several steer calves have made records at leading fairs. A few bull calves have been sold, an option being taken provided they prove to be outstanding breeders.

*Assignment.*—F. W. Farley, for the department; W. A. Cochel, for the Kansas Experiment Station.

*Proposed expenditures, 1918-19.*—Funds supplied by Kansas Experiment Station.

**(Shrinkage of Live Stock during Transportation:** Project completed; results published in Department Bulletin 20.)

[Extension.]

**Beef-Cattle Extension Work:**

*Object.*—To organize associations to improve beef cattle; to encourage co-operative purchasing and selling of breeding animals; to organize baby-beef clubs and bull clubs; to give instructions to farmers by lectures and otherwise on matters of educational value in beef-cattle work; to conduct feeding demonstrations on individual farms for the purpose of demonstrating systems of feeding, management, etc., and to give dehorning, castrating, and vaccinating demonstrations, including personal advice and assistance when possible; in cooperation with the Bureau of Public Roads, to assist in planning and constructing silos and better farm buildings and in giving demonstrations to farmers on the methods of constructing such improvements; to distribute bulletins, circulars, etc., and by personal visits or correspondence give assistance to farmers and live-stock men on all matters pertaining to beef-cattle work.

*Procedure.*—County live-stock associations are organized for the general upbuilding of the live-stock industry. Registered live stock raised by members of such associations are pooled for cooperative sales. Feeding demonstrations with both fattening cattle and stocker cattle are conducted. Personal visits are made to feeders and specific instructions furnished for carrying out the work. County agents assist in the work by seeing that the instructions are carried out and by calling in the specialist in case the results are not as satisfactory as they should be. Demonstrations are given on plastering silos, constructing hoisting device for getting silage out of pit silos quickly and economically, the proper arrangement of sheds, feed lots, feed bunks, etc. All plans for silos, barns, and other farm buildings are furnished by the Bureau of Public Roads.

*Cooperation.*—Agricultural colleges in various States.

*Location.*—Washington, D. C., and the field.

*Date begun.*—1914.

*Results.*—The serious drought in the Southwest hindered the progress of the work during the fiscal year 1918. Most of the time was devoted to the movement of cattle from the drought area to sections where sufficient feed was available. Thousands of cattle which would have died of starvation were moved from Texas and New Mexico into the Southeastern States.

*Assignment.*—F. W. Farley.

*Proposed expenditures, 1918-19.*—\$2,100.

**Total, Beef-Cattle Investigations, \$23,600, including \$1,020 statutory (research, \$21,000; extension, \$2,600).**

(See also Supplement—Emergency Activities, pp. 551-552.)

[Regulation.]

**CERTIFICATION OF PEDIGREES.**

**Certification of Animals Imported for Breeding Purposes:**

*Object.*—To determine the purity of breeding and the identity of animals imported for breeding purposes under the provisions of paragraph 397 of the tariff act of October 3, 1913.



*Procedure.*—In accordance with the provisions of paragraph 397 of the tariff act of October 3, 1913, the customs officials require, for the entry free of duty of animals imported for breeding purposes, certificates issued by the Department of Agriculture stating that such animals are pure bred of a recognized breed and duly registered in the foreign book of record established for that breed. Under authority of this paragraph regulations of this department were issued and designated as B. A. I. Order 206. This order contains a list of the foreign societies recognized by the department and gives detailed directions for obtaining the certificates of pure breeding required by the customs officials. Upon the arrival of the animals at the port of entry they are examined by a Bureau of Animal Industry official, who reports to the Washington office the breed, sex, age, color, and markings. In case the data on the foreign certificates do not agree with the animal imported the bureau declines to issue the certificate of pure breeding. The pedigree given on the certificates is also checked with the published volumes, and those containing errors are returned for correction. In cases where the papers are found to be satisfactory this bureau issues the certificate of pure breeding and sends it to the collector of customs at the port of entry. The foreign certificate is stamped, showing that this bureau has found all papers satisfactory, and is returned to the importer.

*Cooperation.*—Customs Division, Treasury Department.

*Location.*—Washington, D. C., and the field.

*Date begun.*—1911.

*Results.*—During the calendar year 1917 there were imported 613 horses, 387 dogs, and 3 cats, for which certificates of pure breeding have been issued. Under this system of issuing certificates of pure breeding, American buyers, breeders, and record societies are guaranteed that the animals alleged to be imported are as represented. As the tariff act of October 3, 1913, provides for the entry free of duty of cattle, sheep, and swine, certificates of pure breeding are no longer issued by this bureau for those classes of animals. During the calendar year 1915 there were imported 309 horses, 601 dogs and 5 cats, for which this bureau issued certificates of pure breeding. During 1916 there were imported 747 horses, 550 dogs, and 15 cats, for which certificates of pure breeding were issued.

*Assignment.*—G. A. Bell, A. G. Hutton.

*Proposed expenditures, 1918-19.*—\$3,000, including \$600 statutory.

#### SHEEP AND GOAT INVESTIGATIONS.

##### Supervision:

*Object.*—The general supervision of the work in sheep and goat investigations, correspondence, and maintenance of record files pertaining to same.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—F. R. Marshall.

*Proposed expenditures, 1918-19.*—\$4,650 (research, \$2,650; extension, \$2,000).

[Research.]

##### Range Sheep Investigations:

*Object.*—To study methods of range flock management and range sheep breeding problems, the production of a range type of sheep from stock of Rambouillet blood, and the adaptability of Corriedale sheep to western range conditions.

*Procedure.*—The bureau's experimental flock comprises 935 ewes, of which 450 are high-grade Rambouillets, 85 Corriedales, and 400 crossbreds. These sheep are used in various lots to determine the effects of different systems of herding and the effects upon the sheep and upon the range of using fenced pastures, distributed watering places, and various rates of stocking pastures. Individual records kept for all ewes furnish material for studying the factors controlling the size of the lamb crop, the growth of lambs, and the weight and quality of wool.

*Location.*—U. S. Sheep Experiment Station, Dubois, Idaho.

*Date begun.*—1906.

*Results.*—(1) During 1918: Examination of data secured during recent years shows a very definite and previously unrecorded relation between length of fiber and fleece weight for both fine wool and crossbred types of range sheep. The 1917 fleeces of 61 Corriedale ewes, imported in 1914, averaged 8.65 pounds, as compared with 8.35 pounds for Lincoln-Merino ewes of the first cross and 9.86 pounds for grade Rambouillet ewes running upon the same range. The December 1, 1917, weights of ewe lambs of these three lines of breeding were 61.5, 66.25, and 63.64 pounds, respectively.

(2) Prior to 1918: Material advance was effected in developing a type of range sheep combining valuable degrees of capacity for production of both meat and wool. Reports were published showing the breeding value of range ewes that fail to breed in their first mating season, relation of skin folds to wool yield, fleece weights of ewes, and growth of lambs representing different lines of breeding.

*Assignment.*—F. R. Marshall, V. O. McWhorter.

*Proposed expenditures, 1918-19.*—\$20,720.

### Farm Sheep Investigations:

*Object.*—To study the factors controlling yields of lambs and the rate of their growth; to determine for the main types of agricultural conditions in the farm States and for irrigated and dry-land farming areas the lines upon which sheep raising can be made most profitable; and to encourage New England farmers to return to sheep breeding and to furnish data as to returns from the practical management of farm flocks in New England.

*Procedure.*—A flock of 50 registered Southdown ewes is kept at the Morgan Horse Farm, Middlebury, Vt. Records kept permit a full study of the factors affecting reproduction, growth, and fleece characteristics. Experiments are carried on to test the feeding qualities of various classes of lambs produced in the flock and for obtaining data as to economical methods of using native pastures and forage crops in growing lambs and maintaining ewes. A similar flock is kept at the bureau's experiment farm at Beltsville, Md., for the further study of breeding and lamb production. The pasture and forage studies at this farm are planned on lines required by Maryland climatic and soil conditions, and these results will have application to a large area in the South Atlantic States. Thirty acres have been set aside for the exclusive use of experiments in testing methods and the possibilities of intensive sheep farming.

*Location.*—Washington, D. C., and the field.

*Date begun.*—1907.

*Results.*—(1) During 1918: In the Vermont flock 40 ewes were bred in September, 1917. From these, 53 lambs were dropped. No extra lambs resulted from furnishing a grain ration, additional to pasture, to one-half the ewes. A similar result was obtained from the Maryland flock. The addition of grain to a maintenance ration fed during gestation caused a small increase in the birth weights of lambs in two experiments.

(2) Prior to 1918: Extra feeding at mating time caused a larger yield of lambs from ewes in low condition when bred. Twin lambs receiving the same feed as those born singly appeared to attain practically as large weights. Careful matings resulted in a materially increased fleece weight without impairment of mutton development.

*Assignment.*—F. R. Marshall, C. G. Potts.

*Proposed expenditures, 1918-19.*—\$12,140.

### [Extension.]

### Farm Sheep Demonstrations:

*Object.*—To assist in extending the sheep industry in farm States and to show by actual demonstrations on farms how sheep raising may be profitably carried on.

*Procedure.*—Specialists in sheep husbandry will be placed in States adapted to sheep raising, to work in cooperation with the extension divisions of the agricultural colleges through county agents and other agencies whose cooperation will give an impetus to the project.

*Cooperation.*—States Relations Service and State agricultural colleges.

*Location.*—Washington, D. C., and the field.

*Date begun.*—1917.



*Results.*—During the past year 10 cooperative sheep extension specialists were appointed to carry on work in cooperation with the extension divisions of the following States: Connecticut, Rhode Island, Indiana, Massachusetts, Michigan, Minnesota, New Hampshire, Vermont, New York, North Carolina, Texas, and West Virginia. Their work consisted chiefly of special assistance to county agents and in holding meetings and conducting field demonstrations of methods of handling and caring for farm flocks of sheep.

*Assignment.*—F. R. Marshall.

*Proposed expenditures, 1918-19.*—\$37,500.

(See also Supplement—Emergency Activities, p. 553.)

#### [Research.]

### Goat Investigations:

*Object.*—To determine the most economical methods of breeding, feeding, and management of goats for the production of mohair and milk, and to study the value of milk from the milking breeds.

*Procedure.*—A herd of 14 does of the milking breeds is kept at the bureau's experiment farm at Beltsville, Md., for use in testing milk-producing rations. Feeds for artificial rearing are also tested with the young kids. The milk is produced under sanitary conditions and sent to the Dairy Division of this bureau for laboratory use.

*Location.*—Beltsville, Md., and other points in the field.

*Date begun.*—1905.

*Results.*—(1) During 1918: Reports of progress in the study of the value of goats' milk do not indicate the presence of any constant specific qualities of value in the feeding of tubercular adults or adolescents.

(2) Prior to 1918: The results of several years' breeding experiments and a partial report of feeding experiments are included in Farmers' Bulletin 920, "Milk Goats."

*Assignment.*—F. R. Marshall; assistant to be appointed.

*Proposed expenditures, 1918-19.*—\$1,250.

### Studies of Wool and Other Animal Fibers:

*Object.*—To determine for the various grades of wool the lowest shrinkage, due to natural oil, that is consistent with the maximum quantity and quality of wool; to learn how far the presence of skin folds and other body characters are associated with density of fleece and fineness of fiber; to study the relation of climate, soil, and feed, also age and heredity, as affecting the growth and quality of wool and other animal fibers used in commerce; to acquaint woolgrowers with the trade requirements and the various grades of wool; and to inform them regarding the best methods of preparing their clips for market.

*Procedure.*—Samples of wool, with full particulars regarding their source, are obtained from sheep used in the projects "Range Sheep Investigations" and "Farm Sheep Investigations." The laboratory work is done at the bureau's experiment farm at Beltsville, Md. Through bulletins and the circulation of an educational exhibit of wools, sheep raisers are informed regarding breeding for wool and the handling and preparation of clips before marketing.

*Cooperation.*—Bureau of Markets; agricultural colleges in the main sheep-raising States.

*Location.*—Washington, D. C., Dubois, Idaho, and the field.

*Date begun.*—1913.

*Results.*—(1) During 1918: A set of apparatus was designed and constructed for studying the shrinkage of wools as affected by yolk and by foreign matter.

(2) Prior to 1918: A summary of a study of the production and manufacturing values of various types of wools was published as Department Bulletin 206, "The Wool Grower and the Wool Trade." During two seasons an educational wool-exhibit car circulated in a number of the range-sheep States to furnish instruction regarding the classification and grading of wools and their preparation for market.

*Assignment.*—F. R. Marshall.

*Proposed expenditures, 1918-19.*—\$4,400.

**Total, Sheep and Goat Investigations, \$80,660, including \$6,040 statutory (research, \$41,160; extension, \$39,500).**

## SWINE INVESTIGATIONS.

## [Research.]

**Production of Pork:**

*Object.*—To study the effect of different feeds on the growth and quality of hogs and the keeping quality of pork, the effect of feed on the physiological condition of hogs, and the different methods of farm curing and keeping of pork.

*Procedure.*—Pure-bred pigs of each of the lard-type breeds of hogs and high-grade Berkshire pigs bred, raised, and fattened on the Beltsville farm are used. The usual methods of conducting feeding experiments are followed to butchering time. The analysis of different feeds, knowledge of whose digestibility is not available, is determined from representative samples. Tests are made from time to time in cooperation with other bureaus to determine the value of new feeds for pork production. The pigs are slaughtered on the farm at an abattoir fully equipped with modern machinery. Records are kept on all animals slaughtered to determine the weight of offal and vital organs. Data showing the percentage of the carcass that goes to make up the various cuts of the hog are also collected. The meat is cured, smoked, and packed under ordinary farm conditions. An experiment is now under way to determine the effect of ground velvet beans on the quality of pork. Four methods of curing meat under farm conditions are being tried out, and the meat will be kept for periods of from one to two years to determine the keeping quality and the percentage of shrinkage.

*Cooperation.*—Bureaus of Chemistry and Plant Industry.

*Location.*—Beltsville, Md.

*Date begun.*—1905.

*Results.*—Feeding experiments with forage crops, supplemented by a small grain ration, show the value of this practice in the economical production of pork. Results of the advantage of the self-feeder method of fattening over the hand method have been published in a Farmers' Bulletin. A bulletin has been published on the killing of hogs and on improved methods of curing pork.

*Assignment.*—E. Z. Russell, G. A. Anthony, J. H. Zeller.

*Proposed expenditures, 1918-19.*—\$12,160.

(See also Supplement—Emergency Activities, p. 552.)

## [Extension.]

**Organization of Pig Clubs:**

*Object.*—Through the organization of pig clubs, to stimulate production; to teach farm children improved methods of raising, fattening, and marketing hogs; to instill in them, while young, a love of animals which will result in their taking more interest in life upon the farm; and to furnish them at the same time with some work which will, in a practical way, give an insight into the business side of farm life.

*Procedure.*—The assistant in charge of the organization of the clubs works in connection with the county demonstration agents in the States which desire such cooperation. Wherever possible, he obtains the assistance of county superintendents of schools, teachers, and other persons who are in direct contact with young people. After the formation of the clubs, the assistant helps to instruct the members by sending out circular letters, bulletins, etc., which will aid them in their work. He assists in the purchase of pigs, arranges for exhibits, and helps to secure prizes to be offered at the county and State fairs. Complete records are kept of all phases of the work.

*Cooperation.*—States Relations Service and the agricultural colleges in the States where the work is organized.

*Location.*—Washington, D. C., and the field.

*Date begun.*—1912.

*Results.*—The work is now being carried on in the following States: Alabama, Arkansas, Arizona, California, Colorado, Connecticut, Georgia, Indiana, Illinois, Kentucky, Kansas, Massachusetts, New Hampshire, North Carolina, Oklahoma, Oregon, Texas, Tennessee, Vermont, and Washington. Arizona, Colorado, Illinois, Kansas, New Hampshire, Vermont, and Washington have been organized during the past fiscal year. The swine specialists in 17 States supervised 35,980 pig-club members. The average daily gain of the pigs owned by the club members was 1.06



pounds per day. The average cost of grain was \$10.87 per hundred pounds. Seventy-one per cent of the members had pure-bred pigs. In the States reporting there was an increase in membership of 66 per cent up to January 1, 1918. Since that time a spring membership campaign has been under way and the membership on July 1, 1918, is nearly 100,000. The aim is for 200,000 the present fiscal year. Pig-club supplies are being furnished to many States besides those which are doing co-operative club work. Great interest in pure-bred swine is being manifested, and many pure-bred pigs have been shipped into the South for the club members. The pig-club work has led to community organizations and cooperative sales in many of the Southern States. The ham and bacon phase of the club work is having a great influence on the farmer to kill and cure his own pork. Publications prepared this year include a circular on "Swine Judging Suggestions for Pig-Club Members," a circular on "Movable Hog Houses," a pig-club poster, membership card, and a Yearbook separate on "Pig Clubs and the Swine Industry."

*Assignment.*—E. Z. Russell, R. E. Hutton.

*Proposed expenditures, 1918-19.*—\$50,000.

**Total, Swine Investigations, \$62,160, including \$3,900 statutory (research, \$12,160; extension, \$50,000).**

[Research.]

**HORSE AND MULE INVESTIGATIONS.**

**Supervision:**

*Object.*—The general supervision of the work in horse and mule investigations, correspondence, and maintenance of record files pertaining to these projects.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Assignment.*—G. A. Bell

*Proposed expenditures, 1918-19.*—\$4,000.

**Farm Horse and Mule Investigations:**

*Object.*—To study problems in feeding, breeding, and management of horses and mules, with particular reference to their use as farm work animals.

*Procedure.*—The work stock at the bureau experiment farm at Beltsville, Md., will be used in making a study of working and feeding problems. Other work stock on the bureau farm and other farms may be used in these studies.

*Cooperation.*—Other divisions and bureaus of the department.

*Location.*—Washington, D. C., and the field.

*Date begun.*—1916.

*Results.*—In feeding mules used for work on the Arlington Farm, Va., in the winter of 1916-17 cottonseed meal did not prove satisfactory for use under general farm conditions. The animals refused to eat more than 1 pound per day and did not relish the rations with this amount.

During the winter of 1918 four of the mules at the Dairy Division farm, and seven of the work mares at the Animal Husbandry Division farm at Beltsville, Md., received cottonseed meal. The mules and mares were started on  $\frac{1}{4}$  pound per day on October 1, 1917, and gradually increased until the mules are now receiving  $1\frac{1}{4}$  pounds and the mares 2 pounds per day.

*Assignment.*—G. A. Bell, A. G. Hutton.

*Proposed expenditures, 1918-19.*—\$4,840.

**Breeding American Carriage Horses:**

*Object.*—To produce a breed of horses from American material suitable for general purposes.

*Procedure.*—This work was started by the purchase of 6 mares in December, 1904. A second purchase was made in February, 1905, of the standard-bred stallion Carmon and 12 mares, most of them bred in the corn-belt States and Kentucky. Other mares were added in June, 1906, and 4 more in March, 1908. Only the best individuals are retained for this work, and those which are not needed are sold at public auction each year. About 25 mares and 6 stallions are in the stud. These mares were bred to the department stallions during the 1917 breeding season. The stallions were also available for public service, and a number of outside mares were bred to them.

*Cooperation.*—Colorado Experiment Station.

*Location.*—Fort Collins, Colo.

*Date begun.*—1904.

*Results.*—There has been good uniformity in the foals produced in recent years. The stud is now composed almost entirely of animals produced in the experiment, and they possess to a large degree a distinct type. Two of the stallions bred at Fort Collins were leased to outside parties for stud service in 1917, and three will be leased this year.

*Assignment.*—G. A. Bell, David D. Gray.

*Proposed expenditures, 1918-19.*—\$7,740.

### **Breeding Morgan Horses:**

*Object.*—To breed horses under New England conditions, establishing a stud and using horses of Morgan descent as the foundation; to preserve the Morgan type and blood lines. The market requirements and those of the New England farmers are kept in view. A larger horse than the old Morgan will be selected, namely, one standing about 15.2 hands and weighing from 1,050 to 1,100 pounds.

*Procedure.*—Arrangements were made with the Vermont Experiment Station in the fall of 1905 to start this work on the station farm. The first purchase of stock was made in June, 1906, when seven mares and two fillies were bought from various persons in Vermont. In making the selections for the Morgan stud the effort was made to get the true Morgan type with an increase in size and quality over that possessed by the old Morgan. The stallion General Gates was purchased to head the stud in July, 1907, and later in the year two mares were added. Mr. Joseph Battell, of Middlebury, Vt., presented to the department a 400-acre farm in 1907 on which the work could be carried on. The stud was transferred to the farm in April of that year.

*Cooperation.*—North Carolina Mechanical and Agricultural College.

*Location.*—U. S. Morgan Horse Farm, Middlebury, Vt., and other points in the field.

*Date begun.*—1906.

*Results.*—The Morgan stallion Scotland was added to the stud in July, 1916. This horse was foaled in 1906 and is a son of General Gates, the original stallion at the head of the stud, still living. General Gates stands 14 hands 2½ inches and weighs 1,000 pounds. Scotland stands 15 hands ¼ inch high and weighs 1,185 pounds. The colts by Scotland show a considerable increase in size over the average run of Morgan colts. The 3-year-old Morgan stallion Sealskin was added to the stud in December, 1917. This stallion stands 15 hands 3 inches high and weighs 1,200 pounds.

Five stallions from the farm were sent to the eastern part of Vermont for the breeding season of 1917, and probably the same number will be sent for the breeding season of 1918, for use in the production of horses suitable for military purposes. Two of the stallions from the farm are located in southwestern North Carolina. These stallions have sired a nice lot of colts in that territory.

Under authority of the appropriation act for the Department of Agriculture for the fiscal year 1918, a tract of land adjoining the Morgan Horse Farm, consisting of 517 acres, was purchased. The farm now contains over 900 acres and will afford ample pasture land and also much additional land for the production of hay and grain.

*Assignment.*—G. A. Bell, W. F. Hammond.

*Proposed expenditures, 1918-19.*—\$16,540.

### **Breeding Horses on Indian Reservations:**

*Object.*—To improve the quality of horses bred on Indian reservations by proper selection and the use of pure-bred stallions.

*Procedure.*—In 1913, four light (two Standardbred and two Saddlebred) and four draft (Percheron) stallions and four draft (Percheron) mares were purchased with money from the tribal funds of the Indians. The aim of this project is to provide competent Government supervision of the purchase direct from breeders of all stallions used on Indian reservations and of the breeding work done on the reservations.

*Cooperation.*—Interior and War Departments.

*Location.*—Cheyenne River Agency, S. Dak.

*Date begun.*—1913.



*Results.*—During the calendar year 1917, 525 mares were bred, and during 1916, 454.

*Assignment.*—G. A. Bell, Archie Wells.

*Proposed expenditures, 1918-19.*—\$1,020.

### **Breeding Horses for Military Purposes:**

*Object.*—To encourage the breeding of horses suitable for military purposes in localities where such horses are the most profitable type for farm use, and to encourage, in general, better horse-breeding methods among farmers.

*Procedure.*—The department places approved stallions in selected communities which are made available to owners of approved mares on the following terms: Service free in return for an option at \$150 on the resulting foal during the year it is 3 years old. The owner of the foal may be released from his option at any time upon payment of the stipulated service fee. No fee is charged if the Government declines to purchase the foal.

*Cooperation.*—War Department.

*Location.*—Three horse-breeding districts have been organized as follows: First, Vermont and New Hampshire, headquarters at Middlebury, Vt.; second, Virginia and West Virginia, headquarters at Front Royal, Va.; and, third, Kentucky and Tennessee, headquarters at Lexington, Ky.

*Date begun.*—1912.

*Results.*—There were 34 stallions available for the 1917 breeding season, to which were bred 1,575 mares.

*Assignment.*—G. A. Bell, leader; W. F. Hammond, in charge of first district; H. H. Reese, second district; R. G. Lawton, third district.

*Proposed expenditures, 1918-19.*—\$42,180, including \$4,340 statutory.

**Total, Horse and Mule Investigations, \$76,320, including \$8,460 statutory.**

### **POULTRY INVESTIGATIONS.**

#### **Supervision:**

*Object.*—The general supervision of the work in poultry investigations, correspondence, and maintenance of record files connected with these projects.

*Location.*—Washington, D. C.

*Date begun.*—1908.

*Assignment.*—Harry M. Lamon.

*Proposed expenditures, 1918-19.*—\$8,520 (research, \$5,520; extension, \$3,000).

#### **[Research.]**

#### **Farm Poultry Investigations:**

*Object.*—To study the effect of rations, the inheritance of egg production and other characters, the incubation of eggs, brooding, and the effect of free range, of small and large yards, and various styles of houses on the health of fowls and on the fertility of eggs.

*Procedure.*—Pullets and hens are selected and fed rations for comparison. All females are trap-nested to determine their egg-laying ability, and pedigree records are kept of the offspring. Eggs from stock kept under various conditions are hatched in incubators and under natural conditions. Poultry is raised by natural and artificial methods with various styles of equipment.

*Location.*—Washington, D. C., and Beltsville, Md.

*Date begun.*—1910.

*Results.*—(1) During 1918: The feeding experiments in progress at Beltsville, Md., now include 25 pens, several of the pens of old hens having been replaced by pullets. Feeding tests have been conducted with soy and velvet-bean and cottonseed and peanut meal. Rations without wheat or wheat by-products are being used, and the value of cooked vegetables to replace grain in a ration for laying hens is being determined. The rations are being tested especially to furnish information for use under war conditions. Articles on the wheatless ration, rations with cottonseed meal and other high vegetable protein feeds, and on the use of cooked vegetables have been given wide distribution through the extension forces of the department and through the press.

Data are being collected concerning the performance in egg production of pullets from the different matings and with respect to the breed

ing value of the different males and females used in the matings. A considerable number of hens which have laid from 180 to 260 eggs in their pullet year are being used, as well as sons of such females and other males having 200-egg blood on both sides of the pedigree. In the formation of a new breed a considerable number of individuals have been secured having the combination of yellow legs, four toes, red ear lobes, white plumage, and good type, and among the females a few also lay white-shelled eggs. An incubator laboratory is being constructed which will make possible more extensive work in studying incubation.

(2) Prior to 1918: Detailed records of the methods and cost of fattening poultry in commercial fattening stations were published in B. A. I. Bulletin 140, "Fattening Poultry," and Department Bulletin 21, "Commercial Fattening of Poultry." The results of feeding tests covering three years' work with laying hens at Beltsville were published in Department Bulletin 561, "Feeding Cost of Egg Production."

*Assignment.*—Harry M. Lamon, Alfred R. Lee, Rob R. Slocum.

*Proposed expenditures, 1918-19.*—\$10,660.

### **Turkey and Guinea Investigations:**

*Object.*—To study the effect of different rations on the health of breeding stock, egg production, rate of growth of young stock, and fattening for market; to improve the quality of the different breeds; to develop and improve the meat-carrying capacity; to study methods of natural and artificial incubation and brooding; and to study the general management, such as free range and confinement, various styles of housing and shelter, methods of killing and dressing on the farm, and methods for the control and prevention of mortality in turkeys.

*Procedure.*—Methods of feeding and fattening are studied on farms of turkey or guinea raisers in different sections of the country. Eggs are set under turkey, guinea, and chicken hens and in incubators and the poults are brooded by natural and artificial methods. Different methods of killing and dressing are tried out.

*Location.*—Washington, D. C., and the field.

*Date begun.*—1914.

*Results.*—(1) During 1918: In the spring of 1917 arrangements were made for a department representative to raise a large flock of turkeys in cooperation with a large ranch in New Mexico. Careful attention was given to the birds throughout the breeding, laying, hatching, brooding, growing, and marketing seasons and valuable practical information obtained.

(2) Prior to 1918: In September, 1914, a survey of the important turkey and guinea raising sections of the country was started. Many turkey and guinea raisers were interviewed to secure information on their methods of caring for and raising the birds. During 1915 studies were made in the field of methods of raising turkeys in southern Texas. During 1916 similar studies were made in northern New York. As a result of this work Farmers' Bulletin 791, "Turkey Raising," and Farmers' Bulletin 858, "Guinea Raising," were issued.

*Assignment.*—Harry M. Lamon.

*Proposed expenditures, 1918-19.*—\$1,880.

### **Pigeon and Squab Investigations:**

*Object.*—To study methods of rearing, feeding, breeding, housing, killing, dressing, and managing pigeons; to obtain data regarding the production of squabs, the feeding of pigeons, and possible profits to be expected in this industry; to test different breeds of pigeons and the crosses of these breeds to determine their suitability and value for the production of squabs; to study the possibilities of improving prolificacy in different varieties of pigeons by breeding, selection, and feeding; and to breed and train homing pigeons with special reference to use in the Army and Navy.

*Procedure.*—Breeding pairs of pigeons suitable for this work are purchased and bred. A careful study is made of the methods used in establishments where squab raising is conducted. The flock at the Beltsville farm is being carefully studied to determine the economic possibilities of squab raising. During the spring of 1918 homing pigeons of known breeding ability were purchased, and preparations are being made to train and fly the young stock obtained from them.

*Location.*—Washington, D. C., Beltsville, Md., and the field.

*Date begun.*—1915.



*Results.*—As a result of these investigations, Farmers' Bulletin 684, "Squab Raising," has been issued. The stock of pigeons at Beltsville has been materially increased, and this has made possible careful culling and selection.

*Assignment.*—Harry M. Lamon, D. M. Green.

*Proposed expenditures, 1918-19.*—\$340.

### **Ostrich Investigations:**

*Object.*—To study the problems underlying the breeding, feeding, and incubation of ostriches in the United States; to cooperate with the Pathological Division of the bureau in studying the diseases and climatic conditions affecting them; to study the marketing of feathers; and to assist ostrich breeders in the preparation of their product for market.

*Procedure.*—This work was begun by making a study of the grading and marketing of feathers in New York, N. Y., in December, 1913. Since January, 1914, several matings of different varieties of ostriches have been made. The birds have been fed different rations to determine what effect feeding has upon improvement in the quality of the feathers produced. The breeding and feeding experiments are being continued.

*Cooperation.*—Arizona Ostrich Breeders' Association, of Phoenix, Ariz.

*Location.*—Glendale, Ariz.

*Date begun.*—1913.

*Results.*—In December, 1914, a cooperative arrangement was made with members of the Arizona Ostrich Breeders' Association to conduct experiments in ostrich investigations. The department has purchased birds both of the South African and the Nubian varieties and crosses of the two, as it was considered advisable to own the stock used in the experiments. From these birds chicks have been hatched and reared each spring. In December, 1915, another opportunity occurred to secure what were considered several of the best pairs of ostriches owned in the Salt River Valley, and they were purchased and added to the Government flock. During the past year the department leased for a nominal sum 80 acres of land to be used for carrying on this work.

*Assignment.*—Harry M. Lamon.

*Proposed expenditures, 1918-19.*—\$2,500.

### **[Extension.]**

### **Improvement of the Market Egg:**

*Object.*—To conduct an educational campaign looking to the adoption of improved methods of production of the market egg and of its handling from the farm to the country store.

*Procedure.*—A general survey of the field of greatest poultry and egg production was made in the spring and summer of 1908. This was followed by the organization of the egg buyers in Kansas to purchase eggs on the loss-off basis. In this campaign the assistance of the poultry-club workers, farmers, and other producers and handlers of eggs was enlisted. Continued efforts along the same lines are being made to secure improvement in the quality of eggs.

*Cooperation.*—Bureau of Markets, Bureau of Chemistry, States Relations Service, State boards of health, State agricultural colleges, poultry packers, farmers, railroads, and country-store merchants.

*Location.*—Washington, D. C., and throughout the United States.

*Date begun.*—1908.

*Results.*—During 1917 and the preceding years, since the egg placard was issued, over 200,000 of these posters have been sent out into the States in which poultry work is being carried on in continuation of the campaign for the improvement of the market egg. B. A. I. Bulletins—141, "The Improvement of the Farm Egg," and 160, "The Care of the Farm Egg," give the results of this work. An egg placard, which shows the egg in various stages of incubation, was prepared in 1912, and this has proved very valuable in the campaign for better market eggs. A miniature of the placard is to be found in Farmers' Bulletin 528, "Hints to Poultry Raisers." "Rooster Day" was inaugurated and has proved a prime feature in the work for infertile eggs.

*Assignment.*—Harry M. Lamon.

*Proposed expenditures, 1918-19.*—No allotment; work depends on obtaining support from other projects.



### Organization of Poultry Clubs:

*Object.*—Through the organization of poultry clubs, to stimulate an interest in poultry among farm boys and girls; to give a better knowledge of the value and importance of the poultry industry; to encourage better poultry management and the breeding of standard-bred poultry; to standardize poultry and poultry products; and to show how increased revenue may be obtained by marketing a first-class, uniform product.

*Procedure.*—At the request of a State, through the proper extension department, the bureau details a poultry-club agent to serve in the State as a member of the extension department. His duties are to demonstrate to the county agent how poultry clubs are to be organized and to interest such agents in the principles of poultry husbandry. It is proposed to extend this work as appropriations permit, so that young people and others interested may be organized into poultry clubs in the States in which the department has demonstrations in progress. It is also proposed to demonstrate the practicability of poultry production in sections where it is not now carried on extensively and to improve the quality of the output of the farm.

*Cooperation.*—States Relations Service, State agricultural colleges and experiment stations, poultry and egg shipping associations, and breeders of standard-bred poultry.

*Location.*—Washington, D. C., and the field.

*Date begun.*—1912.

*Results.*—(1) During the past year the work was carried on in Virginia, Kansas, North Carolina, South Carolina, Georgia, Kentucky, Tennessee, Oklahoma, Massachusetts, Rhode Island, and Washington. The work has continued to advance along progressive lines in all the States organized. In six of these ten States a number of exhibits were held where prizes were offered for best display of eggs and fowls. The approximate awards in these six States during 1917 amounted to \$2,075.50. The summary for the calendar year 1917 shows ten States organized, with 302 counties, 1,412 clubs, and 14,076 members. These club members during 1917 hatched 114,838 chicks. Standardization or community breeding work, started about a year ago, is being continued with unusual success, with more uniform flocks of poultry as a result. The daily record book for the use of club members has been revised and simplified, which will enable them to submit more complete reports in the future. Four composition outlines for first, second, third, and fourth year members have been prepared which will assist them materially in becoming proficient in their work. The organization of boys' and girls' poultry clubs is meeting with widespread approval.

(2) Prior to 1917: The summary of the work in all States from the organization of Virginia in October, 1912, to 1917 shows eight States organized, with 249 counties, 1,121 clubs, and 11,224 members.

*Assignment.*—Harry M. Lamon, D. M. Green.

*Proposed expenditures, 1918-19.*—\$40,000.

**Total, Poultry Investigations, \$63,900, including \$4,860 statutory (research, \$20,900; extension, \$43,000).**

(See also Supplement—Emergency Activities, p. 552.)

### ANIMAL HUSBANDRY EXTENSION WORK.

#### Animal Husbandry Extension Work:

*Object.*—(1) To carry to the farm the results of the research work of the Animal Husbandry Division; (2) to perfect and carry out systematic, coordinated plans for the production of beef cattle, hogs, sheep, horses, and poultry in sufficient volume to meet the demands on the United States for the successful prosecution of the war.

*Procedure.*—Matters of policy in animal and poultry husbandry extension work are determined upon after consultation and agreement between the chief of the Animal Husbandry Division and the chiefs of the Offices of Extension Work, States Relations Service. The subject matter for extension work is directed by the officers of the Animal Husbandry Division in charge of activities described elsewhere in this statement under the appropriate major-project heads.

*Cooperation.*—States Relations Service and State agricultural colleges.



*Location.*—Washington, D. C., and field.

*Date begun.*—1912.

*Assignment.*—G. M. Rommel, for Animal Husbandry Division; C. B. Smith and Bradford Knapp, for States Relations Service.

*Proposed expenditures, 1918-19.*—No specific allotment; funds will be obtained by assignment from other projects.

**Total, Animal Husbandry Investigations,** \$349,300, including \$40,620 statutory (research, \$206,900; extension, \$139,350; regulation, \$3,050).

[Research.]

## INVESTIGATIONS OF ANIMAL DISEASES.

### Supervision:

*Object.*—Supervision of all the investigations of animal diseases and the performance of duties common to this work.

*Location.*—Washington, D. C.

*Date begun.*—1884.

*Assignment.*—J. S. Buckley, B. H. Ransom, E. C. Schroeder.

*Proposed expenditures, 1918-19.*—\$8,100.

### Rabies Investigations:

*Object.*—(1) The diagnosis of rabies in animals; (2) the study of the disease to find the causative agent and to be able to cultivate this agent by laboratory methods; (3) the determination of the significance of Negri bodies to the causation of rabies.

*Procedure.*—(1) After procuring the head of an animal suspected of being affected with rabies, smear preparations or sections of brain tissues are stained and examined to detect the presence of Negri bodies, which are considered diagnostic for rabies. Intracerebral injections of nervous tissue are made into healthy rabbits or guinea pigs to determine cases of rabies not diagnosable by the above method. Microscopic examinations are made of the nervous tissues of rabbits dead from the inoculation with suspected rabies material from other animals. (2) The actual causative agent being in dispute, the importance of suspected agents—for instance, Negri bodies, bacilli, etc.—is determined by growing these agents in artificial culture media, isolating them in pure cultures, growing them again, and then inoculating susceptible animals with this growth in an endeavor to engender a typical case of rabies. (3) By elimination of all material except Negri bodies, if this is possible, and the injection of these bodies alone into animals, their relation to the disease is studied.

*Location.*—Washington, D. C.

*Date begun.*—1893.

*Results.*—During the past fiscal year 85 brains from suspected cases of rabies were received at the pathological laboratory for diagnosis. Of these 38 dogs and 3 cows were found to be affected.

*Assignment.*—J. S. Buckley, R. J. Formad, W. S. Gochenour.

*Proposed expenditures, 1918-19.*—\$2,870.

### Glanders Investigations:

*Object.*—To determine the presence or absence of glanders infection among the horses and mules of the country; to determine the specificity for mules of a mallein prepared from strains of *Bacillus mallei* isolated from glanders lesions in mules; to determine the value of the conglutination test for the diagnosis of glanders, with special reference to its value in the testing of mule sera.

*Procedure.*—Samples of blood serum are subjected to the complement-fixation and conglutination tests for the establishment of the presence or absence of glanders infection. Mules infected with or exposed to glanders are tested simultaneously with an ophthalmic mallein prepared from mule strains of *B. mallei* and an ophthalmic mallein prepared from horse strains of *B. mallei*, and the results of the two tests are compared. These results in turn are checked by the serum tests and post-mortem examinations.

*Cooperation.*—State officials, practicing veterinarians, and stock owners.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—About 1,300 samples of serum are tested annually. The tests conducted during the fiscal year 1918 indicated that approximately 260 animals were affected with glanders. Sufficient animals have not been tested as yet to draw conclusions as to the specificity of mule mallein for mules. The complement-fixation test has proved very reliable in the detection of glanders, and its use has been given precedence over other methods of testing in the laboratory determination of the disease.

*Assignment.*—J. S. Buckley, H. W. Schoening, F. H. Reynolds.

*Proposed expenditures, 1918-19.*—\$810.

### **Forage Poisoning or Cerebrospinal Meningitis of Horses:**

*Object.*—To determine the causative agent, devise measures for prevention, and detect and study the lesions of this disease.

*Procedure.*—The feeding materials or water that are suspected of being responsible for the disease are observed and studied. Laboratory bacteriological examination of animal fluids and tissues obtained from animals dead of the disease are made. Pathological examinations of the affected tissues are also conducted. By a study of the disease advice can be given to horse owners which may enable them to guard against its occurrence; when the disease is recognizable, however, it has passed beyond the present powers of help. By a study of the lesions of the disease it may be possible to determine whether hitherto unsuspected factors play any part in its causation. Inoculating experiments on horses of the fluids from a diseased horse or of bacterial cultures from diseased horses are made.

*Location.*—Washington, D. C.

*Date begun.*—1884.

*Results.*—Studies made in various parts of the country indicate that "forage poisoning" or "cerebrospinal meningitis" of horses is caused by various etiological agents. For instance, in the Northwest, "staggers" is caused by the eating of the common braeken (*Pteris aquilina*), while in Kentucky it has been caused by feed contaminated with *Bacillus botulinus*, and, in other instances, on account of negative findings, there is reason to believe that other factors are responsible.

*Assignment.*—John S. Buckley.

*Proposed expenditures, 1918-19.*—\$2,700.

**(Investigation of Animal Tuberculosis:** Discontinued as a project under this group; work continued under the section "Investigation, Treatment, and Eradication of Animal Tuberculosis.")

### **Investigation of Animal Abortion:**

*Object.*—To gain further knowledge concerning the etiology, mode of transmission, and practicable means of eradicating the disease; to devise the most satisfactory method of disinfecting contaminated premises; and to determine the presence of the bacillus in suspected samples of market milk.

*Procedure.*—Investigations are conducted with herds where the infection exists under natural conditions and with animals utilized exclusively in an experimental capacity. Cultural work, serological testing, experiment-animal inoculations, and observations are utilized as a means of obtaining information pertaining to the disease. The following phases have been and are to be further studied: Modes of transmission; age at which infection is most liable to occur; the significance of positive serum reactions in virgin heifers and in cows and bulls; the frequency of abortions due to types of infection other than *Bacterium abortus*; pathological changes due to the presence of the infection; the seemingly increased resistance to the infection exhibited by animals raised in an infected environment, and methods of producing a similar resistance to the disease in an artificial manner.

*Cooperation.*—New York State Veterinary College.

*Location.*—Washington, D. C., Bethesda, Md., and Ithaca, N. Y.

*Date begun.*—1908.

*Results.*—It has been demonstrated that the bacterium of infectious abortion occurs in the milk of infected cows; that infected cows remain carriers of the disease long after seeming recovery; that animals that do not seem to find *Bacterium abortus* specifically pathogenic may also serve as carriers; that pregnant heifers raised in an abortion-free en-



vironment can very readily be infected with the disease by the ingestion of minute amounts of abortus-infected material; that abortion infection may, in rare instances, produce marked lesions of the generative organs of bulls; that sows and buffalo may acquire abortion infection under natural conditions and abort in consequence; that, while encouraging results have been obtained in combating the infection by the use of a vaccine, further experimental work is necessary before definite conclusions can be drawn as to the effectiveness and safety of the method; that a fairly large proportion of cows seem to be naturally immune to abortion disease; that the introduction of abortion bacilli into the udder of a cow through her teats leads to their occurrence in the gravid uterus; that the uterus, except during gestation and shortly after parturition, is not a habitat of abortion bacilli; that many cattle which do not abort but carry the abortion bacillus in their udders expel abortion bacilli through their vaginas at and shortly after parturition; that the calves born of infected cows may or may not react with biological tests when they are tested at or shortly after birth; that, when calves react at or shortly after birth, it is very probable that the placenta and the uterus of the mothers are infected with abortion bacilli; that abortion bacilli probably are not expelled from the reproductive organs of infected cows during periods of oestrus; that the ingestion of abortion bacilli is probably one of the most important means of infection; and that abortion bacilli do not seem to persist long in the bodies of nonpregnant cattle except in their udders. Satisfactory treatment of the disease remains to be discovered. It seems that the most important measure that can now be recommended for the control of abortion disease is the separation at the time of parturition of all cows from the herd. Such separation should begin immediately before parturition and be continued for a period of three to four weeks, or longer if parturition is not normal or is followed by abnormal conditions in the cow. It seems at the present time that the two superlatively important factors regarding abortion disease are (1) a specially critical time for the elimination of abortion bacilli from the bodies of infected animals and (2) a specially critical time for the exposure of susceptible animals to abortion bacilli. The first is the time of parturition and shortly after, and the second is the period of gestation.

*Assignment.*—E. C. Schroeder, J. S. Buckley, W. E. Cotton, J. M. Buck, W. L. Williams.

*Proposed expenditure, 1918-19.*—\$54,500.

#### **Investigation of the Birth of Immature and Hairless Pigs and Other Animals and of Goiter in Kids and Lambs:**

*Object.*—To determine the causative agent and to devise preventive procedures.

*Procedure.*—Samples of serum from affected animals are subjected to serologic tests. If suspected causative agents are obtained, these are tested on pregnant females.

*Location.*—Washington, D. C., and Denver, Colo.

*Date begun.*—1913.

*Results.*—The disease which causes the birth of immature and hairless pigs seems to be more prevalent in the far West. The claim that the drinking, by the mothers, of water that melts from glaciers is responsible for the trouble will be investigated as opportunity offers.

*Assignment.*—J. S. Buckley, G. T. Creech, G. W. Stiles.

*Proposed expenditures, 1918-19.*—\$1,000.

#### **Investigation of Swamp Fever:**

*Object.*—To determine the nature, cause, and prevention of the so-called swamp fever of horses; particularly to establish an accurate method of laboratory and clinical diagnosis. This involves a general study of the so-called filterable or ultraviable viruses and new methods of procedure in diagnostic technique.

*Procedure.*—Inoculation experiments and observations of field cases are made. From these material is obtained for laboratory tests in diagnosis, by complement-fixation test or otherwise. The possibility of insect transmission is determined by field observation and by exposure of susceptible horses to various insects.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Results.*—Studies of the transmission of swamp fever from horse to horse have given no definite results, but the number of possible agencies concerned in spreading the infection is so large that much time and work are required for their thorough investigation.

*Assignment.*—J. S. Buckley, L. T. Giltner.

*Proposed expenditures, 1918-19.*—\$2,600.

#### **Diagnosis of and Immunization against Anthrax:**

*Object.*—To differentiate between anthrax and other diseases which bear more or less resemblance to it, so that owners of affected herds may take proper action in the eradication of the disease.

*Procedure.*—The specimen tissues which are removed from animals showing signs of anthrax infection, when received at the laboratory, are inoculated into guinea pigs. Should the inoculation prove fatal within three days, the spleen and kidneys are examined microscopically, the presence of numerous long bacterial filaments with square or concave ends being considered diagnostic of anthrax. Should other organisms be present instead of these, the diagnosis is made accordingly and the owner advised as to the proper course to pursue.

*Location.*—Washington, D. C.

*Date begun.*—1888.

*Results.*—Anthrax is often incorrectly held responsible for causing the loss of live stock, especially in cases of sudden death. Accurate identification of the disease frequently gives great relief to the affected community, while, if anthrax is found, methods of handling the outbreak can be suggested.

*Assignment.*—J. S. Buckley, H. J. Washburn.

*Proposed expenditures, 1918-19.*—\$1,420.

#### **Investigations of Diseases of Fowls:**

*Object.*—To investigate diseases of domesticated birds for the purpose of establishing their causative agents, symptoms, effects on the animal system, and methods for their control; also to diagnose diseases of fowls and give information to owners of affected birds.

*Procedure.*—Numerous diseased fowls, living and dead, are submitted to the laboratory for examination. A study is made of symptoms and pathological changes in the body tissues. Microscopical and bacteriological methods are employed to determine the causative organisms. Transmission experiments are undertaken on birds and other animals. The curative value of remedial agents is determined and the proper dosage established. Biologic products are devised and their efficacy determined for the diagnosis, prevention, or treatment of disease.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—Material received has given opportunity for further study of important poultry diseases. Trials of two kinds of chicken pox and roup vaccines on the market gave unsatisfactory results. An improved diagnostic agent for the detection of *Bacillus pullorum* infection in fowls was developed. A large number of drugs and antiseptics were administered to normal fowls for the purpose of determining their toxicity and proper dose.

*Assignment.*—B. A. Gallagher, L. T. Giltner.

*Proposed expenditures, 1918-19.*—\$2,320.

#### **Miscellaneous Biological Experiments and Investigations:**

*Object.*—To establish methods for the control of hemorrhagic septicemia; to determine the specific nature of diseases affecting animals at the National Zoological Park for the purpose of controlling these diseases; to investigate the cause of mammitis in dairy cows and to devise remedies; and to investigate numerous other diseases as required from time to time.

*Procedure.*—Bacterins are prepared from various cultures of hemorrhagic septicemia, and with these bacterins and living cultures attempts are made to immunize animals of different susceptible species and observe the duration of the immunity thus produced. Animals that die at the National Zoological Park are autopsied, and when necessary a histological study is made of the lesions which are present. Samples of milk are ob-



tained at a city railway station, together with the address of the shipper. These samples are then tested for the purpose of ascertaining whether pathological properties are present in any of the shipments of milk.

*Location.*—Washington, D. C., Bethesda, Md., and Philadelphia, Pa.

*Date begun.*—1884.

*Results.*—Through the examination of animals from the National Zoological Park several cases of aspergillosis have been found in animals never before noted as being susceptible to the disease. This work has also covered the experimental study of germicides, Texas fever, and feeding tests with raw, pasteurized, boiled, and sterilized milk. Chemical tests of market milk are made to determine the presence of enzymes, either harmful or beneficial. Material from 24 cases of mammitis has been examined. Several outbreaks of hemorrhagic septicemia have been investigated, and Department Bulletin 674 describing the disease has been issued. For the year ending June 30, 1917, 12 examinations of animal tissues, stomach contents, etc., were made for arsenic, lead, strychnine, and other poisons.

*Assignment.*—J. S. Buckley, E. C. Schroeder, L. T. Giltner, W. N. Berg.

*Proposed expenditures, 1918-19.*—\$9,790.

### **Index Catalogue and Collection of Parasites:**

*Object.*—Maintenance of a comprehensive card index to the literature of animal parasites and a collection of specimens of parasites for study and reference.

*Procedure.*—Specimens of parasites are collected by bureau employees and by correspondents of the bureau in all parts of the world.

*Cooperation.*—Public Health Service, in maintenance of catalogue; National Museum, in maintenance of the collection of parasites.

*Location.*—Washington, D. C.

*Date begun.*—1890.

*Results.*—The literature of the entire world is rendered readily available by the index catalogue, which has been partially published in cooperation with the Public Health Service. The collection of parasites is one of the largest in existence and is of great value to the work of the Zoological Division.

*Assignment.*—B. H. Ransom, A. Hassall.

*Proposed expenditures, 1918-19.*—\$3,720.

### **Investigation of Roundworms of Sheep:**

*Object.*—To obtain information relating to these parasites and to develop methods for their control and eradication.

*Procedure.*—The parasites are studied in the laboratory and in the field. A flock of sheep has been placed upon a farm near Vienna, Va., leased for the purpose, and experiments are being conducted to determine the effect of various methods of grazing and medicinal treatment upon infestation with stomach worms and other parasites.

*Location.*—Washington, D. C., and Vienna, Va.

*Date begun.*—1914.

*Results.*—It has been shown to be possible to prevent losses among lambs from stomach worms and other internal parasites by following certain methods of pasture rotation combined with medicinal treatment.

*Probable date of completion.*—Farm experiments at Vienna will probably be completed about 1921.

*Assignment.*—B. H. Ransom, Cooper Curtice.

*Proposed expenditures, 1918-19.*—\$11,000.

### **Investigations of Anthelmintics and the Treatment of Live Stock for Internal Parasites:**

*Object.*—To determine the relative values of remedies used against internal parasites, and to work out methods for the practical treatment of live stock to destroy or remove internal parasites.

*Procedure.*—The remedies are administered to animals infested with parasites and the results observed. Laboratory studies are also made. Preliminary tests are supplemented by field tests on a larger scale in cases in which promising results are obtained from the preliminary work.

*Cooperation.*—Insecticide and Fungicide Board. The Zoological Division cooperates by testing in connection with this project remedies concerning which the board desires information.

*Location.*—Washington, D. C., and temporary locations in the field.

*Date begun.*—1915.

*Results.*—Various anthelmintics have been tested and the results published in *Journal Agricultural Research*, vol. 12, No. 7. Oil of chenopodium has continued to give satisfactory results as a remedy for intestinal worms in hogs.

*Assignment.*—W. D. Foster.

*Proposed expenditures, 1918-19.*—\$6,400.

### **Investigation of Parasitic Protozoa, with Particular Reference to Blackhead in Turkeys:**

*Object.*—To study the life histories and characters of these parasites and develop methods for their eradication and control.

*Procedure.*—Laboratory studies are made of various parasitic protozoa. Healthy turkeys are exposed to infection with blackhead, and the biology of the supposed causative organism of the disease and of other organisms and associated with it is studied.

*Location.*—Washington, D. C.

*Date begun.*—1908.

*Results.*—No practical method of controlling blackhead has yet been discovered.

*Assignment.*—H. Crawley.

*Proposed expenditures, 1918-19.*—\$2,980.

### **Investigations of Cattle Ticks, Mange Mites, and Other External Parasites:**

*Object.*—To discover the most effective methods for the eradication and control of external parasites.

*Procedure.*—Various remedies and methods of treatment are tested to determine their efficacy in controlling and eradicating external parasites. So far as possible, bureau inspectors located in the district in which experiments are undertaken are utilized in carrying out the experiments under the direction of the leader.

*Cooperation.*—Bureau of Entomology, where life-history studies of the parasites (insects, ticks, etc.) are made; Insecticide and Fungicide Board (the Zoological Division cooperating by testing in connection with this project remedies concerning which the board desires information).

*Location.*—Headquarters at Kansas City, Kans.; experiments are conducted at various temporary locations in the field.

*Date begun.*—1908.

*Results.*—Farmers' Bulletins—798, "The Sheep Tick," and 909, "Cattle Lice," have been issued. A successful remedy for the ear tick has been discovered and the manuscript for a Farmers' Bulletin has been prepared on this subject. Hog mange has been found to be a much more important disease in the United States than formerly suspected.

*Assignment.*—Marion Imes.

*Proposed expenditures, 1918-19.*—\$9,140.

### **Miscellaneous Investigations of Animal Parasites, Their Control and Eradication:**

*Object.*—To collect information relative to miscellaneous animal parasites and develop methods for their control and eradication.

*Procedure.*—Laboratory and field studies are made. New investigations are undertaken from time to time and old investigations temporarily suspended are resumed as circumstances demand or opportunity offers.

*Date begun.*—1887.

*Results.*—Turkeys have been found to be important carriers of gapeworms. Chickens appear to lose their susceptibility to infestation with gapeworms as they grow older. The infectious stage of the parasites may survive in soil for over a year.

Important facts in the life history of the common intestinal worm of hogs have been determined with reference to the migration of the young stages of the worm through the lungs and the production of pneumonia in young pigs. The importance of special precautions to prevent infection of suckling pigs with this parasite is indicated by investigations not yet completed.

Further work has been done on the effects of extracts of various parasites injected into animals, and experiments have been made in the use of blood tests to determine the presence or absence of internal parasites in animals.



Studies have been made of the parasitic nematodes occurring in the large intestine of horses.

Several publications have been issued during the year giving the results of miscellaneous studies on parasites.

*Assignment.*—B. H. Ransom, W. D. Foster, B. Schwartz, H. B. Raffensperger.

*Proposed expenditures, 1918-19.*—\$3,500.

#### **General Maintenance of Bethesda Experiment Station:**

*Object.*—To provide for overhead expenses incidental to the maintenance and upkeep of the buildings, fences, and equipment at the bureau experiment station at Bethesda, Md., together with the cost of planting and harvesting crops and other operations in connection with running the farm, which items can not be segregated and charged against specific investigational projects.

*Location.*—Bethesda, Md.

*Date begun.*—1897.

*Assignment.*—E. C. Schroeder.

*Proposed expenditures, 1918-19.*—\$20,000.

#### **Breeding and Feeding Small Experiment Animals for Disease Research:**

*Object.*—To breed and have available an abundant supply of small experiment animals of definite, known history for the various investigations conducted by the several laboratories of the Bureau of Animal Industry.

*Procedure.*—Animals are bred under conditions to secure the highest productivity and greatest freedom from disease and weakness.

*Location.*—Bethesda, Md.

*Date begun.*—1889.

*Results.*—It has been proved repeatedly that the small experiment animals bred at the station cost less and are more valuable from every point of view than those which can be purchased.

*Assignment.*—E. C. Schroeder, G. W. Brett.

*Proposed expenditures, 1918-19.*—\$6,540.

#### **Investigations of Stock Poisoning by Plants:**

*Object.*—To collect information in regard to poisonous plants; to determine by chemical examination and feeding experiments, their poisonous principles and effects, with special reference to live stock; and to develop methods of avoiding losses.

*Procedure.*—Chemical analyses of suspected plants are made. Detailed feeding experiments are carried on to determine the symptomatology and pathology exhibited by poisoned animals, and a careful study is made of possible antidotes or other remedial measures. While ordinary laboratory animals are used, the larger part of the work is conducted with those domestic animals (such as cattle, horses, and sheep) whose death from poisonous plants causes heavy losses.

*Cooperation.*—Forest Service and Bureau of Plant Industry.

*Location.*—Washington, D. C., with camps for temporary work in locations where plants are causing trouble. At least one camp is maintained in some part of the grazing region of the West.

*Date begun.*—1904.

*Results.*—The presence of poisonous principles in various plants has been determined and methods of obviating losses from their ingestion developed.

*Assignment.*—C. D. Marsh, A. B. Clawson, J. F. Couch, W. W. Eggleston.

*Proposed expenditures, 1918-19.*—\$12,590.

**Total, Investigations of Animal Diseases, \$161,980, including \$37,420 statutory.**

### **INVESTIGATION, TREATMENT, AND ERADICATION OF HOG CHOLERA.**

#### **Supervision:**

*Object.*—To direct and coordinate research, extension, and control efforts relating to the prevention, suppression, control, and eradication of hog cholera.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Assignment.*—O. B. Hess, T. P. White.

*Proposed expenditures, 1918-19.*—\$11,000 (research, \$1,500; extension, \$1,000; regulation, \$8,500).

[Regulation.]

### Hog-Cholera Control Looking to Eradication:

*Object.*—The control and prevention of hog cholera with a view to the ultimate eradication of the disease.

*Procedure.*—The Bureau of Animal Industry maintains in a number of States a force of competent veterinarians to cooperate with and assist the live-stock sanitary boards, departments of agriculture, or other regulatory authorities of the States in the suppression, control, and eradication of outbreaks of hog cholera through the application of the preventive serum treatment, quarantine, sanitary, and other necessary methods coming within the province of State and Federal regulations.

*Cooperation.*—State officials legally constituted to enforce quarantine and sanitary measures for the control of contagious and infectious diseases of live stock.

*Location.*—Headquarters, Washington, D. C.; field work in Alabama, Arkansas, California, Colorado, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Mississippi, Missouri, Montana, Nebraska, North Carolina, North Dakota, Ohio, Oklahoma, Texas, Utah, Virginia, and Wisconsin.

*Date begun.*—1913.

*Results.*—During 1918 the regulatory phase of the work was extended to include 25 States, supplementing in the additional States work previously conducted along educational lines. The plan of work in these States has been to make early investigations of reported outbreaks of disease, proper diagnoses, and the prompt use of anti-hog-cholera serum where indicated, which have been successful in controlling and preventing destructive outbreaks of hog cholera. Particular attention has been given to the immunization and proper handling of hogs at public stockyards intended for shipment to farms for breeding and feeding purposes, and these efforts have resulted in greatly stimulating the increased production of swine. An important feature of the plan has been to observe and supervise as far as possible the work of practicing veterinarians with the view of making their efforts in the immunization of swine a successful factor in the control of hog cholera and their services of the utmost economic value to farmers.

*Assignment.*—O. B. Hess, T. P. White.

*Proposed expenditures, 1918-19.*—\$229,000.

[Extension.]

### Educational and Demonstrational Hog-Cholera Work:

*Object.*—To prepare county agents and others so that they may intelligently bring to the attention of farmers and stock raisers the organized and efficient methods of treating hog cholera and of preventing the recurrence and spread of the disease.

*Procedure.*—The Bureau of Animal Industry maintains one or more competent veterinarians in each of a number of States, who meet with county agents and others assembled and explain to them through lectures, demonstrations, or otherwise ways in which hog-cholera infection may be introduced and spread and how to prevent the recurrence of the disease and reduce losses through the medium of sanitation and the proper administration of anti-hog-cholera serum, having in mind the dissemination of such information to farmers.

*Cooperation.*—States Relations Service, extension departments of State agricultural colleges, and others authorized to engage in this class of activities.

*Location.*—Headquarters, Washington, D. C.; field work in Alabama, Arkansas, California, Colorado, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Mississippi, Ohio, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, West Virginia, and Wisconsin.



*Date begun.*—1913.

*Results.*—These activities have proved beneficial in disseminating information concerning the preventive serum treatment for hog cholera and the possibility of reducing losses through sanitation; and the proper application of this treatment has been the large factor in stimulating increased production and has resulted in a demand for intensive work in many localities.

*Assignment.*—O. B. Hess, T. P. White.

*Proposed expenditures, 1918-19.*—\$24,000.

[Research.]

**Investigation of Methods of Producing Immunity against Hog Cholera:**

*Object.*—To improve and cheapen present methods of immunizing hogs against hog cholera.

*Procedure.*—Investigations are made of various methods of producing serums and vaccines and of standardizing these products. This involves laboratory studies, supplemented by field tests as required.

*Location.*—Washington, D. C., Ames, Iowa, and Bethesda, Md.

*Date begun.*—1908.

*Results.*—New method for producing clear and heated hog-cholera serum, thus safeguarding that product against danger of foot-and-mouth disease infection, have been perfected and the results published in the *Journal of Agricultural Research*, vol. 6, No. 9. A new process has also been devised for refining and heating old defibrinated blood antitoxin and the results prepared for publication.

*Assignment.*—M. Dorset, R. R. Henley.

*Proposed expenditures, 1918-19.*—\$11,180.

**Investigation of the Cause of Hog Cholera:**

*Object.*—To determine and, if possible, cultivate artificially the specific microorganism of hog cholera.

*Procedure.*—Laboratory studies are made of sick hogs and of the infectious body fluids of such hogs to determine the character of the infectious agent which produces the disease.

*Location.*—Washington, D. C., Ames, Iowa, and Bethesda, Md.

*Date begun.*—1903.

*Assignment.*—M. Dorset, C. N. McBryde.

*Proposed expenditures, 1918-19.*—\$7,500.

**Investigation of the Mode of Dissemination of Hog Cholera:**

*Object.*—To secure definite information concerning the life of hog-cholera virus on infected premises and the ways in which virus is carried from farm to farm as well as from animal to animal.

*Procedure.*—Studies are made of infected premises and of various supposed carriers of hog cholera, including birds and insects. Attempts are made to secure definite information concerning the life of hog-cholera virus in the soil. Other related questions are investigated.

*Location.*—Washington, D. C., Ames, Iowa, and Bethesda, Md.

*Results.*—Investigations have shown that the virus of hog cholera is cast off from the body of sick animals in the excretions and in the eye and nose secretions; that the disease is easily transmitted by inoculation but not so readily by feeding, and that pigeons and birds are unlikely to transmit hog cholera; data published in *Journal of Agricultural Research*, vol. 13, No. 2. Numerous other investigations have been completed, but the results have not yet been compiled.

*Assignment.*—M. Dorset, C. N. McBryde.

*Proposed expenditures, 1918-19.*—\$19,040.

**Total, Investigation, Treatment, and Eradication of Hog Cholera, \$301,720, including \$22,060 statutory (research, \$39,220; extension, \$25,000; regulation, \$237,500).**

(See also Supplement—Emergency Activities, p. 551.)

## [Regulation.]

**CONTROL OF THE MANUFACTURE, IMPORTATION, AND SHIPMENT OF VIRUSES, SERUMS, TOXINS, AND ANALOGOUS PRODUCTS.****Supervision:**

*Object.*—Supervision of all of the work of enforcing the law (virus-serum-toxin act of 1913) governing the interstate shipment and the importation of viruses, serums, toxins, and analogous products intended for use in the treatment of domestic animals, including the direction of upward of 100 employees at the various localities in the United States where such products are prepared and the performance of duties common to the whole work.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Assignment.*—H. J. Shore, D. I. Skidmore.

*Proposed expenditures, 1918-19.*—\$9,000.

**Special Supervisory Inspection:**

*Object.*—To see that the law, regulations, and instructions governing the preparation, sale, barter, exchange, shipment, and importation of viruses, serums, toxins, and analogous products intended for use in the treatment of domestic animals are properly observed.

*Procedure.*—Personal investigations are made of licensed establishments and of the conduct and inspection of operations at establishments which operate under United States veterinary licenses; suspected samples are collected and investigation made of reported violations of the law.

*Location.*—Washington, D. C., Kansas City, Kans., and official stations of supervising inspectors and traveling inspectors.

*Date begun.*—1913.

*Results.*—More uniform conditions at licensed establishments; increased efficiency.

*Assignment.*—H. J. Shore, D. I. Skidmore.

*Proposed expenditures, 1918-19.*—\$6,000.

**Inspection of Establishments:**

*Object.*—To determine whether or not licenses should be issued to establishments engaged in the preparation and disposal of viruses, serums, toxins, and analogous products, and to determine whether the products of licensed establishments are pure and potent.

*Procedure.*—The operations of licensed establishments engaged in the preparation of viruses, serums, toxins, and analogous products are inspected and supervised. This work for the most part consists of inspection of methods of preparation and inspection of tests for purity and potency of anti-hog-cholera serum and hog-cholera virus.

*Cooperation.*—Collectors of customs, Treasury Department.

*Location.*—Washington, D. C., and various cities where licensed plants are located.

*Date begun.*—1913.

*Results.*—During the fiscal year 1917 there were 84 licenses issued, 10 canceled, and 2 revoked; 1 permit was issued; 5,068,417 cubic centimeters of anti-hog-cholera serum, 4,108,306 cubic centimeters of hog-cholera virus for hyperimmunization, and 1,188,601 cubic centimeters of hog-cholera virus for simultaneous inoculations were withheld from the market for the reason that these products were either worthless or contaminated.

*Assignment.*—H. J. Shore, D. I. Skidmore.

*Proposed expenditures, 1918-19.*—\$166,400.

**Total, Control of the Manufacture, Importation, and Shipment of Viruses, Serums, Toxins, and Analogous Products, \$181,400, including \$14,160 statutory.**

## [Regulation.]

**ERADICATION OF DOURINE.****Eradication of Dourine:**

*Object.*—Eradication of this disease in order to prevent its spread and thereby encourage the breeding of horses in districts where dourine is prevalent.



*Procedure.*—All horses in areas where the disease is known to exist are inspected and stallions in such areas removed from the open range. Blood serum from each animal of breeding age is secured and forwarded to the department laboratory at Washington for examination by the complement-fixation method. All reacting mares are slaughtered and all reacting stallions either slaughtered or castrated.

*Cooperation.*—Officials in the various States in which the work is conducted and the Office of Indian Affairs, Department of Interior.

*Location.*—Nebraska, North Dakota, South Dakota, Montana, Wyoming, Arizona, and New Mexico.

*Date begun.*—1912.

*Results.*—During the fiscal year 1917 inspections were made and samples of blood serum from horses tested to the number of 49,585, of which 1,225 or 2.47 per cent gave positive reactions.

*Probable date of completion.*—1921.

*Assignment.*—A. W. Miller.

*Proposed expenditures, 1918-19.*—\$101,200, including \$3,400 statutory.

## CONTROL OF MEAT AND MEAT FOOD PRODUCTS.

### Supervision:

*Object.*—Supervision of all the work of meat inspection, including the direction of some 2,600 employees at all the slaughtering centers of the United States, and the performance of duties common to the whole work.

*Location.*—Washington, D. C.

*Date begun.*—1891.

*Assignment.*—R. P. Steddom, M. Dorset, B. H. Ransom.

*Proposed expenditures, 1918-19.*—\$48,000 (regulation).

### [Regulation.]

### Purchase, Preparation, and Distribution of Brands and Branding Ink:

*Object.*—To provide suitable fluid and branding appliances for marking carcasses, parts of carcasses, and meat and meat food products inspected under the meat-inspection act.

*Procedure.*—Branding ink is prepared in the laboratories at Washington, D. C., and shipped to the inspectors in charge of meat inspection. Careful tests are made to determine what brands and equipment are best for applying the ink.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Results.*—During the past fiscal year 723 gallons of ink were manufactured and 2,006 brass brands procured, bearing the inspection legend and official establishment number, which were supplied to the inspectors for marking meats. The use of the ink and brands has resulted in a saving of many thousands of dollars annually as compared with the cost of marking the meat prior to the inauguration of this system.

*Assignment.*—T. M. Price, W. H. Smith.

*Proposed expenditures, 1918-19.*—\$9,500.

### Special Supervisory Inspection:

*Object.*—To see that the law, regulations, and instructions governing meat inspection are properly observed.

*Procedure.*—Personal investigations are made of official establishments and of the conduct and inspection of operations.

*Location.*—Washington, D. C., Chicago, Ill., Milwaukee, Wis., Omaha, Nebr., Philadelphia, Pa., and Portland, Oreg.; official stations of the traveling veterinary inspectors and experts in sanitation.

*Date begun.*—1906.

*Results.*—More uniform inspection, increased efficiency, and better sanitary conditions have been secured. These favorable results have obtained ever since this system of inspection was inaugurated.

*Assignment.*—R. P. Steddom, George Ditewig, A. J. Pistor.

*Proposed expenditures, 1918-19.*—\$43,500.

**Laboratory Inspection:**

*Object.*—To ascertain whether meat and meat food products prepared in official establishments or under exemption or those shipped interstate by farmers, as well as imported meats and meat food products, are properly labeled, sound, healthful, wholesome, and otherwise fit for human food, and to determine whether any prohibited substance has been used in their preparation or in or about the establishment; also to determine whether the water and ice used in the preparation of meat and meat food products are potable.

*Procedure.*—Samples of all meat, meat food products, and ingredients used in their preparation are collected and submitted to chemical, physical, microscopical, and bacteriological examinations. Chemical and bacteriological examinations are made of samples of all waters and ice used in the preparation of meat and its products. Examinations are also made of various preparations used in and about establishments.

*Cooperation.*—Bureau of Chemistry; Bureau of Internal Revenue. Treasury Department.

*Location.*—Washington, D. C., New York, N. Y., Chicago, East St. Louis, Ill., Omaha, Nebr., Kansas City, Mo., and San Francisco, Cal.

*Date begun.*—1906.

*Results.*—The total number of samples examined during the fiscal year 1917 was 59,916; 832 samples of water were examined and 109 water supplies condemned.

*Assignment.*—T. M. Price.

*Proposed expenditures, 1918-19.*—\$90,000.

**Ante-Mortem Inspection of Animals for Slaughter.**

*Object.*—To discover animals which show symptoms of or are suspected of being affected with any disease or condition which would probably cause their condemnation in whole or in part when slaughtered, and to hold such animals apart and slaughter them separately from other animals so as to insure careful post-mortem inspection as provided in the regulations governing Federal meat inspection.

*Procedure.*—An ante-mortem inspection and examination is made of all cattle, sheep, swine, and goats before they are slaughtered in an official establishment. This consists of visual and digital examinations and, when necessary, recording the temperatures of these animals.

*Cooperation.*—This work is conducted in cooperation with the State and local authorities at a few points.

*Location.*—Washington, D. C., and 124 cities, more or less, throughout the United States at which leaders are stationed. (See list of stations, which follows.)

*Date begun.*—1906.

*Results.*—During the fiscal year 1917 there were inspected 63,816,323 animals, of which 220,109 were marked as "suspects" and 6,336 condemned. Data in the 1917 annual report of the Bureau of Animal Industry. Prior to the year 1917, 556,000,000 animals were inspected and over 1,100,000 tagged as "suspects."

*Assignment.*—R. P. Steddom, George Ditewig, A. J. Pistor. (See also list of stations, which follows.)

*Proposed expenditures, 1918-19.*—\$218,000.

**Post-Mortem Inspection of Animals:**

*Object.*—To make a careful examination and inspection of the carcasses and parts of all cattle, sheep, swine, and goats slaughtered at official establishments to determine the presence of any lesions of disease or other condition which might render the meat or any organ unfit for food purposes; and to condemn and to cause to be destroyed for food purposes all carcasses or parts thereof of animals found on final inspection to be unsound, unhealthful, unwholesome, or otherwise unfit for human food.

*Procedure.*—Visual and digital examinations are made, and, where necessary, the lymphatic glands, organs, or parts are incised.

*Cooperation.*—This work is conducted in cooperation with the State and local authorities at a few places.

*Location.*—Washington, D. C., and 124 cities, more or less, throughout the United States at which leaders are stationed. (See list of stations, which follows.)



*Date begun.*—1906.

*Results.*—During the fiscal year 1917 there were inspected 63,708,148 animals, of which 63,332,644 were passed as suitable for food purposes, 110,108 for sterilization, and 265,396 condemned and destroyed as unfit for food purposes. Prior to the year 1917, 555,000,000 carcasses were inspected, of which 1,875,000 were condemned, together with 6,750,000 parts of carcasses.

*Assignment.*—R. P. Steddom, George Ditewig, A. J. Pistor. (See also list of stations, which follows.)

*Proposed expenditures, 1918-19.*—\$1,320,930.

### **Supervision of the Preparation and Distribution of Meats:**

*Object.*—To inspect meat and meat food products prepared within and brought into official establishments and departments thereof to see that no unfit meat or product is used in the various processes of preparation, packing, salting, smoking, canning, etc., to insure proper labeling, and to see that establishments are maintained in a sanitary condition, that the workers are clean as to person and raiment, and that deleterious preservatives or ingredients are not used; and otherwise to enforce compliance with the meat-inspection law and regulations.

*Procedure.*—All meats, before entering into the preparation of the various products, are examined and inspected physically to see that they are sound, healthful, wholesome, and fit for human food, and that they have been "United States inspected and passed." Each stage in the preparation of the various products is supervised to insure that it is performed under approved sanitary conditions, the products in course of preparation being frequently reinspected in order that no product may be allowed to enter into human consumption which has become unsound, unhealthful, unwholesome, or otherwise unfit for food purposes, or which contains any deleterious dye, chemical, preservative, or other ingredient which would render such product unfit for human food.

*Location.*—Washington, D. C., and 141 cities, more or less, in which leaders are stationed. (See list of stations, which follows.)

*Date begun.*—1906.

*Results.*—During the fiscal year 1917 the work represented inspections equivalent to 7,663,633.957 pounds of meat and products thereof, of which 19,857.270 pounds were condemned as unfit for human food. Prior to the year 1917 the condemnations of meat and products thereof amounted to 215,000,000 pounds.

*Assignment.*—R. P. Steddom, George Ditewig, A. J. Pistor. (See also list of stations, which follows.)

*Proposed expenditures, 1918-19.*—\$1,610,030.

### **Inspection of Meats for the United States Navy:**

*Object.*—To insure that the meat and meat food products furnished the Navy have been inspected and passed and are so marked, that they are sound and fit for food purposes at the time of delivery, and that such articles conform to the specifications of the Navy.

*Procedure.*—The preparation of meat and meat food products for the Navy in accordance with special specifications is supervised to insure that such specifications are met. This supervision includes methods of curing, processing, and handling the articles. Reinspections are made when the articles are delivered to ships, navy yards, and other naval institutions to see that they conform to the specifications and are sound and in every way fit for food.

*Cooperation.*—Bureau of Supplies and Accounts of the Navy Department.

*Location.*—Washington, D. C., Baltimore, Md., Boston, Mass., Bridgeport, Conn., Brooklyn, N. Y., Buffalo, N. Y., Cedar Rapids, Iowa, Charleston, S. C., Chicago, Ill., Cincinnati, Ohio, Dayton, Ohio, Detroit, Mich., Duluth, Minn., Fort Worth, Tex., Honolulu, Hawaii, Jacksonville, Fla., Jersey City, N. J., Kansas City, Kans., Los Angeles, Cal., Mare Island, Cal., Milwaukee, Wis., National Stock Yards, Ill., New Haven, Conn., New Orleans, La., Newport, R. I., New York, N. Y., Norfolk, Va., Omaha, Nebr., Paterson, N. J., Philadelphia, Pa., Portsmouth, N. H., Providence, R. I., Puget Sound, Wash., Richmond, Va., St. Louis, Mo., South St. Joseph, Mo., San Diego, Cal., San Francisco, Cal., San Pedro, Cal., Seattle, Wash., Sioux City, Iowa, Wichita, Kans., and Worcester, Mass.

*Date begun.*—1907.



*Results.*—During the fiscal year 1917 meat and meat food products inspected for the United States Navy amounted to 24,017,321 pounds, of which 682,021 pounds were rejected. This inspection for the Navy for several years has been the means of securing better meat for that department.

*Assignment.*—R. P. Steddom, W. H. Smith.

*Proposed expenditures, 1918-19.*—No allotment; cost of inspection paid by the Navy Department.

### **Inspection at Public Markets:**

*Object.*—To provide for the interstate transportation or export from public markets of portions of inspected and passed meats and products thereof which, when cut or otherwise removed from a marked carcass, part, or container, do not show the inspection legend.

*Procedure.*—The unmarked portions of meats cut from a properly marked carcass or meat food products removed from a properly marked container in the presence of a bureau inspector are examined by him and, if found to be sound, healthful, wholesome, and fit for human food, are marked with the inspection legend.

*Location.*—Washington, D. C., and 41 cities, more or less, in which leaders are stationed. (See list of stations, which follows.)

*Date begun.*—1908.

*Results.*—This inspection has permitted shippers to forward in interstate and foreign commerce meats which otherwise would have been prohibited shipment from the State.

*Assignment.*—R. P. Steddom, George Ditewig, A. J. Pistor.

*Proposed expenditures, 1918-19.*—\$15,000.

### **Supervision of Operations Conducted under Certificates of Exemption:**

*Object.*—To ascertain whether or not shippers are retail butchers, retail dealers, or farmers and therefore entitled to exemption under the meat-inspection law; also to see that the premises in which animals are slaughtered or where meat and meat food products are prepared by or for persons who make interstate shipments under exemption from inspection are maintained in a sanitary condition, and that the articles so shipped are sound, healthful, wholesome, and fit for human food.

*Procedure.*—The inspectors visit and examine the premises and ascertain the character of the business of the shipper. If the provisions of the regulations are met, numbered certificates of exemption are issued. These certificates are required in connection with the interstate transportation of meat and meat food products. In case the holder of a certificate of exemption fails to conform to the regulations, his certificate is revoked.

*Cooperation.*—State officials having jurisdiction over meat and its products within the State.

*Location.*—Washington, D. C., and 64 cities, more or less, in which leaders are stationed. (See list of stations, which follows.)

*Date begun.*—1906.

*Results.*—At the close of the fiscal year 1917 there were 2,456 exemption certificates outstanding. During that year 67,779 shipments were made by retail butchers under authorization of the certificate of exemption. Similar favorable conditions for shipments by retailers have obtained ever since this supervision has been effective.

*Assignment.*—R. P. Steddom, W. H. Smith.

*Proposed expenditures, 1918-19.*—\$12,000.

### **Examination of Imported Meats and Meat Food Products:**

*Object.*—To prevent the importation of meat and meat food products of cattle, sheep, swine, and goats which are not properly certified, or which are falsely labeled, or which are unsound, unhealthful, unwholesome, or otherwise unfit for human food, or which contain any prohibited dye, chemical, preservative, or other harmful ingredients.

*Procedure.*—The foreign certificates of all shipments of meat and products offered for importation are examined to see that they conform to the department regulations. The meat and meat food products are carefully inspected and examined. Samples of consignments are given chemical examination. Only such products are admitted as are sound, healthful, wholesome, and fit for human food, are free from prohibited dye,



chemicals, preservatives, and other harmful ingredients, and are properly labeled.

*Cooperation.*—Treasury Department and in certain instances the Bureau of Chemistry.

*Location.*—Washington, D. C., and 27 cities, more or less, in which inspection of imported meats and meat food products embraced under this project is made.

*Date begun.*—1913.

*Results.*—During the past year 29,138,996 pounds of imported meat were examined, of which 382,150 pounds were condemned and 14,611 pounds refused entry.

*Assignment.*—R. P. Steddom, W. H. Smith.

*Proposed expenditures, 1918-19.*—\$50,000.

#### Field Overhead, and Miscellaneous Meat Inspection:

*Object.*—To cover the overhead charges at the meat-inspection stations throughout the United States, also minor activities not included under other projects of this group.

*Procedure.*—Various minor transactions incidental to the maintenance of meat inspection at 144 cities, more or less, in the field, the transfer of employees between stations, and other miscellaneous items which are common to the control of meats and products thereof at such cities.

*Location.*—At 144 cities and towns, more or less, throughout the United States.

*Date begun.*—1891.

*Assignment.*—See list of stations, which follows.

*Proposed expenditures, 1918-19.*—\$145,500.

#### [Research.]

#### Bacteriological Investigations of Meat and Meat Food Products:

*Object.*—To conduct bacteriological investigations of meat and meat food products for the purpose of securing information to aid inspectors in determining the proper disposition of questionable meat and to enable packers to prevent spoilage.

*Procedure.*—Bacteriological studies relating to the spoilage of meats and meat food products are undertaken as special problems arise in connection with various procedures of the packing house.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—The cause of ham souring has been worked out and suggestions offered for its prevention. The reliability of the hot-room test as a means of detecting defective cans has been established and regulations governing the reprocessing of such cans adopted. The canning of sausage in oil has been investigated, and as a result regulations governing the preparation of this product have been adopted. The bacteria in the carcasses of hog-cholera hogs have been studied, with the result that no organisms of *Bacillus enteritidis*, or meat-poisoning type, were encountered. A bacteriological investigation of beef-ham pickles has been made, and as a result the use of these pickles in the manufacture of meat extracts has been prohibited. The process of dehairing and washing hog carcasses has been investigated, and it has been found that under certain conditions hair and dirty wash water entered the wound in the neck and penetrated through the blood vessels as far as the liver. Instructions were issued with a view to prevent this trouble. Reports have been made on the routine examination of meat samples, including (1) samples suspected of having caused meat poisoning, (2) samples which have undergone putrefactive changes such as would render them unfit for food, and (3) samples showing various discolorations due to molds and other causes.

*Assignment.*—C. N. McBryde.

*Proposed expenditures, 1918-19.*—\$2,000.

#### Investigation of Changes in Meats during Preservation:

*Object.*—To improve methods of preservation and conserve curing materials.

*Procedure.*—Methods of preservation and the changes which take place in meats and curing materials during preservation are studied.

*Location.*—Washington, D. C., and other cities where meat-packing establishments under Government inspection are located.

*Date begun.*—1913.

*Results.*—The causes and nature of the changes which take place in fresh beef during cold storage have been determined. Investigations relating to cured meats are in progress. Reports of work under this project have been published under the following titles: "Effect of Autolysis upon Muscle Creatin," Journal of Agricultural Research, vol. 6, No. 14; "Formation of Hematoporphyrin in Ox Muscle during Autolysis," Journal of Agricultural Research, vol. 7, No. 1; "Changes in Fresh Beef during Cold Storage above Freezing," Department Bulletin 433; "The Quantitative Estimation of Dextrose in Muscular Tissue," Journal of Biological Chemistry, vol. 31, No. 1; "The Function of Muscular Tissue in Urea Formation," Journal of Biological Chemistry, vol. 31, No. 3; "Glycolytic Properties of Muscular Tissue," Journal of Biological Chemistry, vol. 31, No. 3.

*Assignment.*—Ralph Hoagland, C. N. McBryde.

*Proposed expenditures, 1918-19.*—\$3,000.

### **Investigation of Canned Meats:**

*Object.*—To develop, through chemical and bacteriological studies, information concerning the effect which prolonged storage has upon canned meats.

*Procedure.*—Chemical and bacteriological examinations are made from year to year of several kinds of canned meats which have been stored since 1909.

*Location.*—Washington, D. C., and certain cities where meat-inspection establishments are operating under supervision of the Federal Government.

*Date begun.*—1909.

*Results.*—Work incomplete; will continue for several years. Analyses are made once each year.

*Assignment.*—T. M. Price, C. N. McBryde.

*Proposed expenditures, 1918-19.*—\$1,000.

### **Investigation of Dried Meats:**

*Object.*—To determine the practicability of producing a wholesome, palatable dried meat in the United States, particularly for the use of troops in the field or for shipment over long distances.

*Procedure.*—Methods of drying now in vogue, as well as new methods, will be studied. The kinds of meat which can best be prepared in dry form will be determined and studies made of changes which take place in meat during drying and of methods of preparing dried meats so as to render them palatable. After the laboratory phases of this investigation are completed, any work looking to the industrial development of the project will be undertaken in close cooperation with the Bureau of Chemistry.

*Location.*—Washington, D. C., and other cities where facilities for drying meats are available.

*Date begun.*—1918.

*Assignment.*—H. H. Custis.

*Proposed expenditures, 1918-19.*—\$5,000.

### **Investigation of the Use of Meat and Meat Food Products for Industrial Purposes:**

*Object.*—To determine the amounts and kinds of meat food products used in the industries and to develop suitable inedible substitutes, with a view to the conservation of meat and meat food products for food purposes.

*Procedure.*—The amounts and kinds of meat products used in the industries will be determined, and each use will be studied with the object of securing a suitable inedible substitute for the meat products now diverted to industrial use. This work will involve the securing of data, chemical studies in laboratories, and probably also practical tests of substitutes which may be proposed.

*Cooperation.*—Bureau of Chemistry (informal).

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Assignment.*—Ralph Hoagland.

*Proposed expenditures, 1918-19.*—\$2,000.



**Investigations of Pathological Conditions Noted during Meat Inspection:**

*Object.*—The investigation of any abnormal, unusual, or hitherto unnoted condition of interest, directly or indirectly, from the meat-inspection viewpoint, which may be encountered during routine Federal meat inspection. Special emphasis is laid upon infectious conditions and those characterized by malignancy.

*Procedure.*—Bacteriological examination is made of meat in the fresh state by means of unstained and stained smears as well as by culture sowings from the tissue under investigation, for the purpose of demonstrating or eliminating material of an infectious nature and likewise differentiating and recovering, where possible, the causative agent. The suspected material is prepared by freezing or other hardening methods so that the tissue involved may be sectioned and studied microscopically in regard to its histologic structure for the recognition of any deviations from the normal that may be present.

*Location.*—Washington, D. C., Chicago, Ill., and South Omaha, Nebr.

*Date begun.*—1906.

*Results.*—Pathological conditions of a puzzling character are frequently discovered during meat inspection. Careful laboratory investigation of these unusual changes permits an intelligent disposition to be made of the affected carcasses.

*Assignment.*—H. J. Washburn, L. E. Day, G. B. Morse.

*Proposed expenditures, 1918-19.*—\$10,000.

**Zoological Investigations Relating to Meat Inspection:**

*Object.*—To improve methods of meat inspection so far as parasitic diseases of food animals are concerned.

*Procedure.*—Parasitic conditions found in the course of meat inspection are investigated. Problems relating to specific parasites are studied with reference to their bearing on meat inspection. These studies are continued from year to year, different problems being taken up in turn. Special investigations of trichinosis will be continued at Chicago and Washington.

*Location.*—Washington, D. C., and various meat-inspection stations.

*Date begun.*—1884.

*Results.*—A set of regulations governing the preparation in official establishments of pork products customarily eaten without cooking has been issued. These regulations are based upon extensive investigations of methods of preparing such products so as to insure the destruction of trichinae, which cause a serious and frequently fatal disease in human beings. Nematodes belonging to the genus *Oncocerca* and related to the parasite which is found in the worm nodules of Australian beef have been found in cattle in the United States, but in contrast to the Australian parasites they appear to have little or no importance in meat inspection.

*Assignment.*—B. H. Ransom, W. N. Neil, H. B. Raffensperger.

*Proposed expenditures, 1918-19.*—\$4,500.

**Investigations upon the Control of the House Fly and Other Insects in Establishments Operating under Federal Meat Inspection:**

*Object.*—To devise plans for the control and eradication of the house fly and other insects in establishments operating under Federal meat inspection.

*Procedure.*—Study is made of conditions in establishments and surroundings with reference to the fly problem. Experiments in the control and eradication of flies are carried out in establishments at Dallas, Tex., and elsewhere.

*Cooperation.*—Bureau of Entomology.

*Location.*—Washington, D. C., Dallas, Tex., and various meat-inspection stations.

*Date begun.*—1915.

*Results.*—Some of the best methods of trapping flies have been determined and instructions issued in Service and Regulatory Announcements for January, 1916.

*Assignment.*—George H. Parks.

*Proposed expenditures, 1918-19.*—\$1,000.

**Total, Control of Meat and Meat Food Products, \$3,590,960, including \$113,760 statutory (regulation, \$3,562,460; research, \$28,500).**



## MEAT-INSPECTION STATIONS.

Location.	Character of work. <sup>1</sup>	Date begun.	Assignment.	Proposed expenditures, 1918-19.
Albany, N. Y.	A, B, C, D, G	1909	E. H. Baumann	\$8,800
Albert Lea, Minn.	A, B, C, D	1914	G. W. Knorr	7,050
Allentown, Pa.	A, B, C, D, G	1906	G. W. Famous	8,050
Alton, Ill.	A, B, C, D	1906	Jas. Johnston	4,000
Amarillo, Tex.	C, D	1918	J. C. Dixon	2,000
Andalusia, Ala.	A, B, C, D	1916	E. N. Tierney	2,500
Arkansas City, Kans.	A, B, C, D	1906	J. E. Shelton	3,150
Atlanta, Ga.	C, D	1918	B. L. Larimore	1,600
Auburn, Me.	A, B, C, D	1906	L. K. Conley	3,000
Augusta, Ga.	A, B, C, D, F, G	1908	J. E. Lovejoy	11,500
Austin, Minn.	A, B, C, D, F	1901	E. W. Barthold	17,800
Baltimore, Md.	A, B, C, D, E, F, G	1904	H. A. Hendrick	50,000
Billings, Mont.	A, B, C	1918	E. V. Beaumont	2,500
Birmingham, Ala.	A, B, C	1916	W. H. Meadors	3,300
Bisbee, Ariz.	A, B, D	1915	J. T. Gaston	1,750
Boise, Idaho.	A, B, C, D, G	1916	W. D. Wright	3,150
Boston, Mass.	A, B, C, D, E, F, G, H	1895	J. F. Ryder	94,000
Bridgeport, Conn.	C, D, E, G, H	1909	J. F. Reimer	1,350
Bristol, Va.	A, B, C, D, G	1917	J. B. Hill	2,000
Brooklyn, N. Y.	A, B, C, D, E, F, G	1895	A. Long	42,000
Buffalo, N. Y.	A, B, C, D, E, F, G, H	1892	B. P. Wende	74,500
Burlington, Vt.	A, B, C, D, G	1906	C. C. Conley	2,000
Butte, Mont.	A, B, C, D	1917	W. R. Richards	4,600
Calais, Me.	A, B, D	1914	H. T. Potter	1,350
Cedar Rapids, Iowa	A, B, C, D, E	1896	F. Jelen	23,800
Chattanooga, Tenn.	A, B, C, D, G	1912	F. H. Collins	2,150
Cheyenne, Wyo.	A, B, C, D	1907	W. Hamilton	3,200
ChIPLEY, Fla.	A, B, C, D	1918	J. R. Aufente	1,900
Chicago, Ill.	A, B, C, D, E, F, G, H, I	1891	W. N. Neil	534,000
Cincinnati, Ohio	A, B, C, D, E, G	1895	D. C. Burnett	83,200
Cleveland, Ohio	A, B, C, D, F, H	1892	H. H. George	70,000
Columbus, Ohio	A, B, C, D	1906	O. W. Everly	6,000
Cumberland, Md.	C, D, G	1908	A. C. Shafer	1,500
Davenport, Iowa	A, B, C, D, F, G	1896	P. A. Franzman	4,300
Dayton, Ohio	A, B, C, D, E	1906	A. F. Staub	13,000
Denver, Colo.	A, B, C, D, F, G	1903	C. F. Payne	36,500
Des Moines, Iowa	A, B, C, D	1918	C. W. Deming	9,500
Detroit, Mich.	A, B, C, D, E, F, G, H	1899	E. P. Schaffter	42,500
Dubuque, Iowa	A, B, C, D, G	1906	W. C. Bower	3,100
Duluth, Minn.	A, B, C, D, E, F, G, H	1906	Chester Miller	4,100
Eau Claire, Wis.	A, B, C, D	1899	W. Fotheringham	4,300
El Paso, Tex.	C, D, G	1907	T. A. Bray	3,500
Evansville, Ind.	A, B, C, D	1906	L. Metsker	5,200
Fargo, N. Dak.	C, D, G	1909	E. H. Clark	1,350
Fergus Falls, Minn.	A, B, C, D, G	1907	M. L. Davenport	2,000
Fort Smith, Ark.	C, D	1909	W. B. Nichols	1,400
Fort Wayne, Ind.	A, B, C, D	1906	J. Miller	5,000
Fort Worth, Tex.	A, B, C, D, E	1902	C. L. Norris	70,000
Fostoria, Ohio	A, B, C, D	1916	R. Turnbull	2,000
Frederick, Md.	A, B, C, D, G	1917	C. B. Weagly	2,000
Grand Rapids, Wis.	A, B, C, D, G	1909	F. O. Kickbusch	3,000
Green Bay, Wis.	C, D	1917	T. H. Baker	1,500
Hallstead, Pa.	A, B, D	1908	S. M. Page	2,000
Harrisburg, Pa.	A, B, C, D	1906	W. C. Siegmund	7,500
Hartford, Conn.	C, D, F	1906	W. E. Jennings	1,500
Haverhill, Mass.	A, B, C, D, F, H	1906	H. Q. Thompson	7,000
Houston, Tex.	A, B, C, D	1906	C. F. Palmer	12,500
Huntington, W. Va.	A, B, C, D	1916	H. W. McMaster	2,500
Indianapolis, Ind.	A, B, C, D	1892	G. W. Butler	75,000
Jacksonville, Ill.	A, B, C, D	1906	J. B. Clancy	3,200
Jacksonville, Fla.	A, B, C, D, E, H	1909	E. F. Haven	5,600
Jersey City, N. J.	A, B, C, D, E, F, G	1891	J. S. Jenison	45,500
Kansas City, Kans.	A, B, C, D, E, G, I	1891	J. Fleming	274,500
Keene, N. H.	A, B, C, D	1908	T. W. Carnachan	3,500
La Fayette, Ind.	A, B, C, D	1906	C. H. Herrold	4,400
Leavenworth, Kans.	A, B, C, D	1917	C. C. Walch	2,200
Lewiston, Idaho	A, B, C, D	1907	F. G. Miller	4,500
Logansport, Ind.	A, B, C, D	1906	John Keppel	4,700
Los Angeles, Cal.	A, B, C, D, E, F, G, H	1896	G. T. Irons	35,200
Louisville, Ky.	A, B, C, D, F, G	1896	S. L. Bond	18,700
Madison, Ind.	A, B, C, D	1906	W. H. Timmons	2,000
Madison, Wis.	A, B, C, D	1917	S. S. Snyder	3,200
Manchester, N. H.	C, D, F	1907	J. Hurley	1,500
Mason City, Iowa	A, B, C, D	1904	C. J. Millen	11,700
Memphis, Tenn.	A, B, C, D, G	1906	T. H. Berry	6,000

<sup>1</sup> The letters in this column have the following meaning: A, ante-mortem inspection of animals for slaughter; B, post-mortem inspection of animals; C, supervision of the preparation and distribution of meats; D, field overhead and miscellaneous inspection; E, inspection of meats for the Navy Department; F, inspection at public markets; G, supervision of operations conducted under certificates of exemption; H, examination of imported meats and meat-food products; and I, laboratory inspection.



*Meat-Inspection Stations—Continued.*

Location.	Character of work. <sup>1</sup>	Date begun.	Assignment.	Proposed expenditures, 1918-19.
Menominee, Mich.....	A, B, C, D, G.....	1911	E. C. Carle.....	\$2, 200
Milwaukee, Wis.....	A, B, C, D, E, F, G, H.....	1891	A. E. Behnke.....	67, 300
Morristown, Tenn.....	A, B, C, D, G.....	1907	C. P. Hart.....	3, 100
Moscow, Idaho.....	A, B, C, D, G.....	1911	F. A. Barber.....	1, 600
Moultrie, Ga.....	A, B, C, D.....	1914	G. T. Cole.....	3, 000
Nashville, Tenn.....	A, B, C, D, G.....	1904	W. B. Lincoln.....	6, 000
Natchez, Miss.....	A, B, C, D, G.....	1908	P. J. Huffman.....	7, 000
National Stock Yards, Ill.....	A, B, C, D, E, H, I.....	1892	E. L. Bertram.....	118, 700
Nebraska City, Nebr.....	A, B, C, D.....	1901	A. M. Casper.....	6, 700
Newark, N. J.....	A, B, C, D, F, G, H.....	1904	A. F. Martins.....	35, 400
New Haven, Conn.....	A, B, C, D, E, F.....	1899	W. T. Conway.....	7, 600
New Orleans, La.....	A, B, C, D, E, F, G.....	1906	R. W. Tuck.....	17, 400
New Richmond, Wis.....	A, B, C, D.....	1917	O. J. Lanigan.....	2, 700
New York, N. Y.....	A, B, C, D, E, F, G, H, I.....	1891	L. D. Ives.....	180, 000
Norfolk, Va.....	C, D, E, F, G.....	1908	J. M. Harris.....	3, 400
North Fork, W. Va.....	C, D.....	1914	W. P. Collier.....	1, 500
Ogden, Utah.....	A, B, C, D, G.....	1906	E. D. Kennedy.....	6, 100
Oklahoma, Okla.....	A, B, C, D.....	1906	J. S. Grove.....	46, 500
Omaha, Nebr.....	A, B, C, D, E, F, G, H, I.....	1906	H. Busman.....	171, 700
Ottumwa, Iowa.....	A, B, C, D, G.....	1892	P. J. Brady.....	24, 600
Paterson, N. J.....	A, B, C, D, E, G.....	1906	A. McBride.....	16, 600
Peoria, Ill.....	A, B, C, D.....	1906	A. N. Hughes.....	11, 300
Philadelphia, Pa.....	A, B, C, D, E, F, G, H.....	1893	C. A. Schaufler.....	85, 000
Pittsburg, Kans.....	A, B, C, D.....	1906	J. E. Blackwell.....	2, 000
Pittsburgh, Pa.....	A, B, C, D, G, H.....	1892	G. E. Totten.....	30, 100
Portland, Me.....	A, B, C, D, F, G, H.....	1896	F. W. Huntington.....	7, 400
Portland, Oreg.....	A, B, C, D, F, G, H.....	1897	E. C. Joss.....	21, 300
Pottsville, Pa.....	A, B, C, D.....	1906	G. H. Woolfolk.....	6, 100
Providence, R. I.....	A, B, C, D, E, F, G, H.....	1906	H. M. Smith.....	24, 200
Pueblo, Colo.....	A, B, C, D.....	1906	B. F. Gooch.....	4, 200
Quincy, Ill.....	C, D, F.....	1908	L. H. Howlett.....	1, 350
Reading, Pa.....	A, B, C, D, G.....	1914	R. O. Rothermel.....	4, 000
Reno, Nev.....	A, B, C, D, F.....	1906	L. C. Butterfield.....	4, 300
Richmond, Ind.....	A, B, C, D.....	1906	C. O. Wagoner.....	2, 700
Richmond, Va.....	A, B, C, D, E, F, G.....	1906	H. Marshall.....	13, 300
St. Louis, Mo.....	A, B, C, D, E, F, G, H.....	1895	J. J. Brougham.....	67, 800
Salt Lake City, Utah.....	C, D, H.....	1906	L. B. Dunlap.....	2, 400
San Diego, Cal.....	A, B, C, D, E.....	1901	J. E. Cloud.....	5, 300
San Francisco, Cal.....	A, B, C, D, E, F, G, H, I.....	1895	H. H. Hicks.....	28, 300
Seattle, Wash.....	A, B, C, D, E, F, G, H.....	1900	J. Madsen.....	29, 600
Shreveport, La.....	C, D.....	1908	L. Bryant.....	2, 200
Sioux City, Iowa.....	A, B, C, D, E, G.....	1894	T. A. Shipley.....	76, 700
Sioux Falls, S. Dak.....	A, B, C, D.....	1906	E. S. Dickey.....	28, 100
Smithfield, Va.....	C, D.....	1908	H. F. Gordon.....	1, 500
South St. Joseph, Mo.....	A, B, C, D, E, F.....	1898	A. O. Lundell.....	109, 900
South St. Paul, Minn.....	A, B, C, D, G.....	1895	M. O. Anderson.....	47, 900
Spokane, Wash.....	A, B, C, D, G.....	1906	R. W. Culbert.....	18, 000
Springfield, Mass.....	C, D, F, G, H.....	1906	H. E. Brown.....	15, 000
Stamford, Conn.....	C, D.....	1913	F. W. Hellriegel.....	1, 400
Tacoma, Wash.....	A, B, C, D, H.....	1904	E. C. Craven.....	10, 050
Terre Haute, Ind.....	A, B, C, D.....	1912	L. H. Allen.....	5, 500
Texarkana, Tex.....	C, D.....	1913	H. G. Potter.....	1, 400
Tifton, Ga.....	A, B, C, D.....	1918	J. I. Martin.....	4, 100
Toledo, Ohio.....	A, B, C, D, G.....	1906	S. W. Burt.....	8, 800
Topeka, Kans.....	A, B, C, D.....	1901	F. S. Bingham.....	7, 700
Union City, Tenn.....	A, B, C.....	1918	F. J. Verduin.....	3, 100
Walla Walla, Wash.....	A, B, C, D.....	1907	W. B. Henneberger.....	4, 100
Washington, D. C.....	A, B, C, D, E, F, G.....	1906	H. K. Walter.....	19, 200
Waterloo, Iowa.....	A, B, C, D, G.....	1900	F. T. Suit.....	10, 500
Watertown, S. Dak.....	A, B, C, D.....	1913	R. G. Rice.....	2, 000
Wausau, Wis.....	A, B, C, D.....	1916	R. J. Digman.....	2, 700
Waycross, Ga.....	A, B, C.....	1916	C. L. E. Kerr.....	1, 750
Wheeling, W. Va.....	A, B, C, D, F.....	1906	J. S. Kelly.....	16, 100
Wichita, Kans.....	A, B, C, D, E.....	1897	F. D. Ketchum.....	37, 600
Wilkes-Barre, Pa.....	C, D.....	1917	I. H. Bailey.....	1, 500
Winona, Minn.....	A, B, C, D, G.....	1907	C. L. Elliott.....	4, 900
Wilmington, Del.....	A, B, C, D, F, G.....	1906	G. E. Repp.....	5, 300
Wilmington, N. C.....	A, B, C, D.....	1913	W. M. Palmer.....	4, 200
Worcester, Mass.....	A, B, C, D, E, F, G.....	1898	M. T. Perry.....	9, 900
Total, Meat-Inspection Stations.....				2 3, 367, 200

<sup>1</sup> The letters in this column have the following meaning: A, ante-mortem inspection of animals for slaughter; B, post-mortem inspection of animals; C, supervision of the preparation and distribution of meats; D, field overhead and miscellaneous inspection; E, inspection of meats for the Navy Department; F, inspection at public markets; G, supervision of operations conducted under certificates of exemption; H, examination of imported meats and meat food products; and I, laboratory inspection.

<sup>2</sup> The expenses of 104 substations, not separately reported, are included in this amount. This total includes \$113,760 statutory salaries.

## BUREAU OF PLANT INDUSTRY.

### GENERAL ADMINISTRATION.

#### Office of Chief:

*Object.*—The effective administration of the affairs of the Bureau of Plant Industry and general direction of all of its investigational activities.

*Cooperation.*—Other offices of the department, other departments, and State experiment stations.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—William A. Taylor, chief; K. F. Kellerman, associate chief.

*Proposed expenditures, 1918-19.*—\$31,460.-

#### Office of Assistant to the Chief:

*Object.*—General supervision of the clerical force and janitor service of the bureau, purchase of supplies and equipment, handling mail, operation and maintenance of central file room and property room, and all matters pertaining to appointments, pay rolls, and leaves of absence.

*Cooperation.*—Other offices of the department and other departments.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—James E. Jones.

*Proposed expenditures, 1918-19.*—\$40,380.

#### Editorial Work:

*Object.*—To edit and prepare for printing manuscripts and to read and revise proofs of articles submitted for publication by investigators of the bureau; also similar work in connection with all printing required by the bureau.

*Cooperation.*—Other bureaus of the department and the Division of Publications.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Assignment.*—J. E. Rockwell.

*Proposed expenditures, 1918-19.*—\$9,870.

#### Accounts:

*Object.*—The systematic administration of the fiscal affairs of the bureau.

*Cooperation.*—Disbursing office of the department; the Treasury Department.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—W. P. Cox.

*Proposed expenditures, 1918-19.*—\$27,130.

#### Library:

*Object.*—To maintain a working reference collection of the department books on botany; to furnish to the bureau scientists bibliographical assistance in the use of the library resources of the department and of those of other libraries in and outside of Washington; to maintain mailing lists for publications, and do other work for the bureau for which a knowledge of the department library methods and botanical bibliography is essential.

*Procedure.*—Records of books in use are kept in accordance with the system employed by the department library. Current periodicals are circulated regularly, with a follow-up system to insure prompt service. Current phytopathological literature is indexed, and reference and bibliographical work is done as need develops. References appearing in bureau publications and in the Journal of Agricultural Research are edited according to approved rules. Records are kept of books purchased on bureau funds for field stations. A central mailing list, domestic and foreign, is maintained.



*Cooperation.*—Department library and branch libraries, Library of Congress, and other libraries in and outside of Washington.

*Location.*—Washington, D. C.

*Date begun.*—1900.

*Assignment.*—Eunice R. Oberly.

*Proposed expenditures, 1918-19.*—\$10,510.

**Total, General Administration,** \$119,350, including \$88,330 statutory (research \$75,880; extension, \$22,470; regulation, \$21,000).

[Research.]

## LABORATORY OF PLANT PATHOLOGY.

### GENERAL LABORATORY INVESTIGATIONS.

#### General Laboratory Investigations:

*Object.*—To ascertain the life history of fungi and bacteria parasitic on plants, with a view to discover means of prevention and remedies for various diseases.

*Procedure.*—The work involves microscopic examination of diseased material in fresh condition and also when imbedded in paraffin, sectioned, and stained; isolation of organisms from the diseased tissues and study of their life histories on various culture media; inoculation experiments in the hothouses and elsewhere; testing various fungicides, germicides, etc.; field study when the cases are serious enough to warrant it.

*Cooperation.*—The bulk of the work is laboratory work, usually within the department; occasionally cooperative experiments are undertaken in certain localities.

*Location.*—Washington, D. C., and at any point in the field where conditions demand personal attention.

*Date begun.*—1901.

*Results.*—(1) Prior to 1918: Many important plant diseases have been studied, carefully worked out, and reported upon. The dissemination of the bacterial disease of sweet corn has been traced to diseased seed, and methods of treatment and prevention have been recommended. Knowledge underlying much of the experimental work now done on the brown rot of potatoes, tomatoes, eggplant, and peppers and the wilt of tobacco was obtained as a result of investigations by this laboratory, where the organism causing these diseases was isolated and determined. This parasite causes annually losses of many thousands of dollars. Work has been under way on the tobacco end of the disease in Florida.

The cause of wilt in cucurbits has been determined and its distribution by insects shown, and studies of this disease with reference to remedies are under way.

The exact cause of the olive tubercle has been demonstrated and the cause of the brown rot of the cabbage worked out and described.

The cause of the destructive melon wilt of the South was also discovered and methods for control worked out. These discoveries led to many other researches in various parts of the world on the *Fusarium* type of wilt, which is the cause of many of our very destructive plant diseases. It was also proved that cabbage yellows is due to another *Fusarium* and that *Fusariums* are in all probability responsible for many of our worst parasitic plant diseases.

Studies on crown gall have been continued and have shown that two quite distinct types of tumor, i. e., with or without leafy shoots, can be produced by the same organism, depending on the place of inoculation. Tumors bearing roots or leafy shoots and even flowers have been produced by pure-culture inoculations of *Bacterium tumefaciens*—these, too, in parts of the plant where no dormant buds were known to occur. Such leafy tumors have even been produced in the middle of leaves. The shoots in such tumors are usually very embryonic or fragmentary and strongly suggest the embryomas occurring in animals. The researches on crown gall have not only thrown a flood of light on a difficult horticultural problem but have also awakened great interest among medical men and animal-research investigators on account of their bearing on tumors in animals.

(2) During 1918: During the past year the principal energies of the laboratory have been devoted to the study of a threatening bacterial disease of wheat which has suddenly sprung up in the Middle West.  
*Assignment.*—Erwin F. Smith.  
*Proposed expenditures, 1918-19.*—\$34,913, including \$8,020 statutory.

#### SPECIAL INVESTIGATIONS.

##### Control of Bacterial Wilt of Tobacco:

*Object.*—To determine means of preventing and eradicating the bacterial wilt disease of tobacco.

*Procedure.*—New methods of cultivation and of soil management are studied in the field and this work checked up by similar experiments in the laboratory and greenhouse, where more exact control of conditions is possible.

*Location.*—Laboratory and greenhouse work in Washington, D. C.; field experiments in Gadsden County, Fla., and later possibly at other points in Florida, as well as in Georgia.

*Date begun.*—1912.

*Results.*—The field work of the season of 1916-17 successfully demonstrated that it is feasible to control Granville wilt on land grown continuously in tobacco, that is, that rotation is not necessary. The work for the season of 1917-18 was discontinued because of the absence of the leader on military duty.

*Assignment.*—R. E. B. McKenney.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

##### Bacterial Wilt of Cucurbits:

*Object.*—To further investigate the biological and soil relations of the causal organism (*Bacillus tracheiphilus*), to devise methods of control for the disease, and to ascertain further its distribution.

*Procedure.*—The investigation comprises cultural studies of the causal organism and inoculation experiments in greenhouse and field with a view to work out further the biological relations of the organism. A histological and cytological study of the relation between host and parasite is being made.

*Location.*—The principal investigations under this project have been conducted in the Laboratory of Plant Pathology, Washington, D. C., at Giesboro Point, D. C., Tuxedo, Md., and in the neighborhood of Greenport (L. I.), N. Y.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: The summer transmission by *Diabrotica* spp. has been further confirmed and the implication of these insects as winter carriers experimentally demonstrated. Successful control of the disease has been effected by a spray combining bactericidal, insecticidal, and repellent properties. Stomatal infections were found not to occur. Various insects other than *Diabrotica* have given negative results as carriers of bacterial wilt. Some of the more recent studies have been presented in an article entitled "Transmission and Control of Bacterial Wilt of Cucurbits," published in the *Journal of Agricultural Research*, vol. 6, No. 11.

(2) During 1918: Two publications have been made and a third is in manuscript detailing the results of further work on winter and summer transmission of the organism, relation of the bacteria to insects, distribution of the disease, results of further control work, and studies of the causal organism, including differences in virulence, viability in soil and in culture, cultural characters, etc.

*Probable date of completion.*—1919.

*Assignment.*—Frederick V. Rand.

*Proposed expenditures, 1918-19.*—\$4,000.

##### Alternaria Leaf Diseases of Cucurbits:

*Object.*—To complete the life-history work on the causal organism (*Alternaria brassicae* var. *nigrescens* Peglion) and to devise methods of control for the disease.



*Procedure.*—The investigation comprises cultural studies of the causal organism and inoculation experiments to further work out the life history and biological relations of the organism.

*Location.*—Laboratory and greenhouse experiments at Washington, D. C., and field observations and experiments in the neighborhood of Greenport (L. I.), N. Y.; in addition, observations made in connection with other field trips through Maryland, Delaware, New Jersey, Michigan, Wisconsin, Indiana, and Iowa.

*Date begun.*—1892.

*Results.*—Successful cultural studies and inoculations have been carried out and observations made through certain truck-growing sections of the Atlantic and Middle Western States. The project was suspended during the past season because of pressure of work on grain diseases.

*Assignment.*—Erwin F. Smith.

*Proposed expenditures, 1918-19.*—\$2,062.

### **Diseases of Pond Lilies and Other Aquatic Plants:**

*Object.*—To establish the causes, work out the life histories, and develop methods for the control of diseases of cultivated pond lilies and other aquatic plants.

*Procedure.*—Cultural studies of the causal organisms and inoculation experiments in greenhouse, laboratory, and field are made to establish causal relations and life histories.

*Location.*—Washington, D. C.; collecting and observation trips in the neighborhood of Greenport (L. I.), N. Y.

*Date begun.*—1913.

*Results.*—Spraying experiments, cultural studies, and inoculation work were in progress for several seasons on a *Helicosporium* leaf-disease doing considerable damage at aquatic gardens at Kenilworth, D. C. The results of this investigation, together with recommendations for controlling the disease, were embodied in an article entitled "Leafspot Rot of Pond Lilies Caused by *Helicosporium Nymphaearum*," published in the *Journal of Agricultural Research*, vol. 8, No. 6.

Investigations of several other fungous diseases of pond lilies and of a rather serious fungous leaf-spot of lotus were in progress during the fiscal year 1918. The results obtained have been reported in an article now in the hands of the printer.

*Assignment.*—Frederick V. Rand.

*Proposed expenditures, 1918-19.*—\$895.

### **Black Chaff of Wheat:**

*Object.*—To determine the cause of this recently discovered disease of wheat, its geographical extent and destructiveness, and mode of distribution from year to year and to develop methods for its control.

*Procedure.*—Observations are made in the field, material collected and examined microscopically in the laboratory, and cultural studies of the organisms occurring in the diseased parts and inoculations with the same made to determine the parasite. Critical studies of the latter are made and germicidal and other experiments for eradicating the disease or restricting its spread carried out.

*Cooperation.*—University of Wisconsin and Agricultural College of Kansas.

*Location.*—Greenhouse, laboratory, and open-air experiments at Washington, D. C.; field observations and laboratory experiments in Wisconsin and Kansas.

*Date begun.*—1917.

*Results.*—Because of the rapidity with which this disease spreads, it appears to have in it great possibilities for evil. Study during the past season was confined principally to the States from Texas northward to Canada. The occurrence of the disease has been identified in 14 States of the Middle West and also in one locality in California on a total of more than 100 farms. It appears to be most widely distributed at present from Kansas to other States north and south on seed wheat. It does not now occur east of the Mississippi River except to a very limited extent in bordering States where it has been recently introduced. A preliminary account of the disease was published in the *Journal of Agricultural Research*, vol. 10, No. 1.

*Assignment.*—Erwin F. Smith.

*Proposed expenditures, 1918-19.*—\$5,000.

**Bacterial Diseases of Corn:**

*Object.*—To investigate the extent and manner of distribution of Stewart's disease of sweet corn (*Bacterium stewarti*) and other bacterial diseases of corn with a view to determine causes and means of control and eradication.

*Procedure.*—The investigations include laboratory studies of causal organisms and observations and experiments in the field to determine the methods of transmission and exact distribution of the diseases, as well as the extent of the danger to field corn, with a view to educate the growers in the practice of field hygiene and other methods of control. With regard to Stewart's disease, the particular points of interest are: Studies on seed and soil transmission, seed disinfection, relation of rotation to control, varietal differences in susceptibility, and distribution.

*Location.*—Laboratory and greenhouse studies at Washington, D. C.; field experiments at Tuxedo, Md.; incidental field trips through the corn belts of various States.

*Date begun.*—1917.

*Results.*—Seed corn of leading varieties has been obtained from most parts of the United States for a corn nursery and tests made as to the seed transmission of Stewart's disease and other bacterial diseases. Soil-transmission experiments in the greenhouse have been in progress for several months, and field experiments are under way.

*Assignment.*—Frederick V. Rand.

*Proposed expenditures, 1918-19.*—\$5,000.

**Total, Special Investigations, \$16,957.**

**Total, Laboratory of Plant Pathology, \$51,870, including \$8,020 statutory.**

[Research.]

**PATHOLOGICAL COLLECTIONS.****Pathological Herbarium:**

*Object.*—To maintain a collection of fungi demonstrative of the important economic bearing of fungi upon agricultural crops. The specimens comprising the herbarium are arranged with a view to assist mycological and pathological investigators in solving research problems or in the practical application of such problems.

*Procedure.*—Valuable pathological or mycological material is acquired by the purchase of American and foreign sets of exsiccati. Specimens identified by members of the office for mycologists, pathologists, collaborators, amateur collectors, or correspondents are retained, and other specimens are secured through the medium of the mycological exchange, through the deposition of type material by authors, through the agency of the Plant Disease Survey, and by collections made by members of the office staff.

*Location.*—Washington, D. C.

*Date begun.*—1885.

*Results.*—During the past year additional fire, insect, and dust-proof cases were purchased, bringing the total number up to 60. Over 1,600 specimens were acquired and inserted, not including permanent microscopic slides. Additional centuries or fascicles of exsiccati have been received as follows: Bartholomew, North American Uredinales, Century 17; Bartholomew, Fungi Columbiani, Centuries 49 to 51; Brenckle, Fungi Dakotenses, Fascicles 16 and 17; and Baker, Fungi Malayana, Century 3. The office was fortunate in securing from the Bayard Taylor Memorial Library the rare and valuable collections of Michener. The set contained over 7,000 specimens, being authentic specimens of an early American mycologist.

*Assignment.*—Flora W. Patterson.

*Proposed expenditures, 1918-19.*—\$3,677.

**Mycological Index and Host Index:**

*Object.*—To provide information relative to new genera or species; to furnish data regarding the geographical distribution of diseases, their intensity, and measures of control or eradication.



*Procedure.*—This project includes two distinct lines of work, one pertaining to the herbarium as furnishing an inventory of the fungi comprising the herbarium and their respective hosts, and the other providing abstracts, translations, and illustration of new, contested, or imperfectly known genera, species, or diseases.

*Location.*—Washington, D. C.

*Date begun.*—1885.

*Results.*—The conspicuous activity in mycological and pathological lines has resulted in the acquisition of a large number of cards referring to these subjects. As in past years the following general divisions have been observed: Indexing of all new genera, including the generic diagnosis, a copy of the illustrations, and author's notes or comments; indexing of new species, both American and foreign; geographical index with special reference to the indiginity of species; nomenclatorial index pertaining to common names of fungi and fungous and physiological diseases of all countries and in all languages; index of fungi pathogenic to man and animal; subject index, consisting of references to and abstracts from all pathological and mycological subjects, whether of a technical, general, or semipopular nature, particular attention being given to diseases the causal organisms of which have not been determined, several thousand cards being added to the indexes as a result of this work.

*Assignment.*—Flora W. Patterson.

*Proposed expenditures, 1918-19.*—\$2,223.

### **Mycological Exchange:**

*Object.*—To exchange mycological specimens with educational institutions and interested private individuals with the view of promoting general dissemination of economic mycological and pathological information.

*Procedure.*—Specimens are sent from the mycological exchange to experiment stations, agricultural institutions, collaborators, demonstrators, teachers of agriculture in secondary schools, and others especially interested in the economic study of fungi. This phase of the subject has been educational in character, but by the exchange of specimens with foreign mycologists much interesting material has been received by the office.

*Location.*—Washington, D. C.

*Date begun.*—1898.

*Results.*—This project has been a very important medium for the dissemination of pathological information, providing agricultural schools and colleges and other institutions possessing limited equipment with material for demonstration purposes. The value of the mycological exchange to the department has been the acquisition of herbarium material not always rare but showing varietal differences in specimens representative of wide geographical distribution.

*Assignment.*—Flora W. Patterson.

*Proposed expenditures, 1918-19.*—\$2,355.

### **Work of Identification:**

*Object.*—The determination of fungi, in order to discover the causal agent of disease and thus enable the pathologist to devise or recommend measures for control.

*Procedure.*—This work may be considered under two heads—pathological identification and mycological identification. Under pathological identifications are included the determination of species of fungi causing diseases of plants. Microscopic examinations are often sufficient for the solution of problems connected with well-established diseases, but new diseases always require a study of the life history of the causal organisms and relation to fungi already recognized as pathogenic. These identifications frequently require cultural work, critical microscopic comparisons with authentic specimens, and inoculation experiments. Under mycological identifications may be understood the determination of fungi of taxonomic rather than pathological interest. The value of this work is constantly recognized, as field observations often reveal the parasitic nature of fungi at first supposed to be of systematic interest only.

*Location.*—Washington, D. C.

*Date begun.*—1885.



*Results.*—The subject of mushroom cultivation has received considerable attention during the past year. Through the collaboration of several large mushroom growers various experiments have been inaugurated with the object of determining the necessary or most favorable chemical constituents of manure. It was found necessary to secure definite data upon this subject, as the character of the food of animals was found to have a very direct and potent influence upon the success or failure of mushroom growing. Investigations are in progress relative to the germination of spores in the preparation of spore-culture spawn.

Work has been continued on the subject of soil fungi, and scores of culture have been made and many species identified.

Observations have been continued on the smut disease of bamboo. Important data have been deduced in regard to the manner in which the disease is carried, the longevity of the spores and mycelium, and their period of incubation and development.

A prolonged study has been made of a serious disease of rose. Field observations, artificial inoculations, and a study of the life history of the causal organism have been made. The results are about ready for publication.

A new disease of belladonna is at present a subject of investigation.

Investigations have been made of a disease of pine which occurs in Canada and extensively abroad but has not yet become established in the United States, although imported on a foreign shipment. This shipment was not distributed.

Several new species of fungi of economic interest have been studied and technical descriptions written. This work will be ready for publication during the present year.

A considerable amount of critical work has been performed for monographers or authors of new species. This work has been done for various scientists regardless of their official governmental connections or university affiliations.

Manuscripts or descriptions of new species have been submitted for correction or criticism. During the present year attention was given to the synonymy of all the organisms discussed in a textbook on the subject of vegetable pathology.

*Assignment.*—Flora W. Patterson, Vera K. Charles, Anna E. Jenkins.

*Proposed expenditures, 1918-19.*—\$3,755.

**Total, Pathological Collections, \$12,010, including \$3,360 statutory.**

#### [Research.]

### PLANT-DISEASE SURVEY.

#### General Survey of Plant Diseases:

*Object.*—To record the geographical distribution, annual prevalence, and rate of spread of diseases of economic plants in the United States, and to estimate the amount of loss occasioned by them; to discover new and possibly dangerous diseases as soon as possible after their introduction into the country in order that restrictive measures may be advised; to study epidemics and unusual outbreaks of diseases in relation to various factors and to obtain a better knowledge of conditions governing the development, spread, and control of plant diseases; to gather data on the resistance and susceptibility of varieties to disease, practical effectiveness of various control methods, and other points of value in disease control work; to maintain close relations with pathologists and agriculturists generally and to cooperate with them by furnishing data needed in their studies on the nature and control of plant diseases.

*Procedure.*—Every attempt will be made to extend and improve the plant-disease information service started last year. It is aimed to utilize as many as possible of the reliable sources of information on plant-disease occurrence. A closer contact will be established with collaborators of the Plant-Disease Survey in the various States. Additional efforts will be made to assist those men in securing and making more complete and more accurate reports on survey matters and in developing and systematizing the work within their respective States. Greater cooperation will



be secured with plant pathologists of the department and with other persons who are in a position to furnish reliable data.

The information thus collected will be made available by means of the Plant-Disease Bulletin and special reports. The Plant-Disease Bulletin will be enlarged by the inclusion of more data and rendered more valuable by the use of more timely and more complete reports. This publication is intended primarily for plant pathologists and leaders in plant-disease control work.

So far as time permits special problems connected with plant-disease geography and related topics will be studied. Diseases or outbreaks of particular importance will be personally investigated by members of the staff or by collaborators.

*Cooperation.*—No formal cooperation with the experiment stations is entered into, the collaborators mentioned acting as department officers, so that the project may be treated as entirely under the Bureau of Plant Industry.

*Location.*—Washington, D. C., and throughout the United States.

*Date begun.*—Preliminary work inaugurated in 1898 and carried on as a joint project of the pathological offices; first organized under separate appropriation in 1917.

*Results.*—Previous to July, 1917, when the Plant-Disease Survey was first organized as a separate office, a large amount of information had been brought together regarding the distribution and prevalence of plant diseases within the United States. These data are on file in card-catalogue form. Much of this information has already been published or in various ways reported to interested workers. The records are being enlarged and improved.

Since July 1, 1917, the organization of the survey has been improved, both in the department and in the various States. The contact with Federal and State workers has been extended and made closer, with the result that better knowledge of plant-disease conditions has been obtained. The office has kept in touch with the more important disease problems in most of the States by means of correspondence, conferences, and frequent questionnaires. The data accumulated during the summer have been made available by means of the Plant-Disease Bulletin, a semi-monthly mimeographed publication, started August 15, 1917. Estimates of crop losses from diseases and a general or annual State report have been secured from collaborators.

*Assignment.*—G. R. Lyman, R. J. Haskell, G. H. Martin.

*Proposed expenditures, 1918-19.*—\$9,620.

### **Pure-Culture Supply Laboratory:**

*Object.*—To establish a central laboratory where plant pathologists may deposit pure cultures of pathogenic organisms and where the living cultures may be maintained indefinitely; to maintain pedigreed sub-cultures from the type cultures or authentic cultures deposited at the laboratory; to supply authentic or accurately identified pure cultures of the various pathogenic organisms to plant pathologists, quarantine and inspection officers, and others engaged in pathological work.

*Procedure.*—The work will be continued in a small way. Such cultures as are received will be handled, but no attempt will be made to solicit or advertise cultures until a trained mycologist can be secured and detailed especially to this duty.

*Cooperation.*—Informal cooperation with department and State pathologists and with private individuals.

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Results.*—Some inquiry has been made into the problems presented, including details of equipment and organization, scope, needs to be served, and methods to be followed. A few cultures have been received. Owing to the more urgent need for survey work, less attention has been paid to this project than would have been given in times of peace.

*Assignment.*—G. R. Lyman, R. J. Haskell, G. H. Martin.

*Proposed expenditures, 1918-19.*—\$1,100.

**Total, Plant-Disease Survey, \$10,720, including \$1,200 statutory.**

(See also Supplement—Emergency Activities, p. 556.)



## [Research.]

## FRUIT-DISEASE INVESTIGATIONS.

## SUPERVISION.

## Supervision:

*Object.*—To handle administrative, clerical, and such service and laboratory work as pertains more or less to all the fruit-disease projects.

*Cooperating.*—Bureau of Entomology, Insecticide and Fungicide Board, and Federal Horticultural Board.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—M. B. Waite.

*Proposed expenditures, 1918-19.*—\$8,440, including \$5,620 statutory.

## GENERAL ORCHARD DISEASES.

## Pear-Blight Investigation and Eradication:

*Object.*—To complete the knowledge of pear blight by working out further details; to improve methods of control already devised, and to demonstrate to orchardists, inspectors, and others the best methods known; to breed pears and apples resistant to this disease, including stocks on which to graft other varieties.

*Procedure.*—Laboratory work, microscopical and bacteriological, is conducted; also field investigations and experiments, mostly nearby in Virginia and Maryland; eradication work in the orchards in various parts of the country, particularly in California, Washington, and Oregon; breeding work in the vicinity of Washington and at Arlington Farm, Va.

*Cooperation.*—Extensive cooperation in the field with State and county horticultural commissioners, fruit-tree inspectors, experiment-station workers, and orchardists, particularly on the Pacific coast.

*Location.*—Washington, D. C., Arlington Farm, Va., and orchards in various parts of the country, particularly in California, Washington, Oregon, Virginia, and Maryland.

*Date begun.*—1889.

*Results.*—A method of control by eradication has been discovered. This has been quite largely but not completely put into practice in different sections, particularly on the Pacific coast, and has resulted in saving the pear industry in California, Washington, and Oregon and in benefits to other pear and apple sections.

*Probable date of completion.*—The research work has been practically completed, though certain phases, as the diseases reappears each year, call for further detailed studies, particularly studies of infection methods and insect distribution of the disease. The date of completion of the eradication work and cooperation in control of the disease is somewhat indefinite.

*Assignment.*—M. B. Waite, E. A. Siegler, L. M. Hutchins, H. W. Truesdell.

*Proposed expenditures, 1918-19.*—\$2,000.

## Little-Peach and Peach-Yellows Investigations:

*Object.*—To investigate the nature, distribution, and method of control of the peach-yellows group of diseases, including, in addition to peach yellows and little peach, peach rosette and certain other stone-fruit diseases which appear to be related, and to assist the various States in control work.

*Procedure.*—This project involves certain incidental laboratory studies but principally field-service work in promoting the control.

*Cooperation.*—In control work, with various State and county horticultural inspectors.

*Location.*—Laboratory work, Washington, D. C.; field work, mainly control, probably in Michigan, New York, Pennsylvania, Connecticut, Virginia, and Maryland.

*Date begun.*—Begun by Erwin F. Smith in 1887; transferred to M. B. Waite in 1899.

*Results.*—The cause of these diseases has not yet been discovered. A practical method of control of peach yellows by eradication has been extensively promoted by this work. Little peach has been classified in



the peach-yellow group and a practical method of control by eradication discovered and developed.

*Assignment.*—M. B. Waite, E. A. Siegler, L. M. Hutchins.

*Proposed expenditures, 1918-19.*—\$400.

#### **Crown-Gall Diseases of Fruits:**

*Object.*—To make available to orchardists results of research; to aid nurserymen and orchardists in eliminating the disease; to carry on field tests for this purpose.

*Procedure.*—Assistance is rendered to nurserymen and orchardists to control the disease and to State and local horticultural inspectors by deciding doubtful cases. Field tests are conducted in propagating healthy trees, and observations are made on the behavior of diseased trees when planted in orchards.

*Cooperation.*—Nurserymen, orchardists, and various State and county horticultural inspectors.

*Location.*—Laboratory work, Washington, D. C.; service work, various orchard sections of the United States.

*Date begun.*—1900.

*Results.*—Important steps toward control in nurseries have been made. The results of the work of other investigators are made available to growers.

*Assignment.*—M. B. Waite, E. A. Siegler.

*Proposed expenditures, 1918-19.*—\$400.

#### **Pollination of Orchard Fruits:**

*Object.*—To continue an old project by perfecting knowledge of certain details of pollination and fruit-setting problems.

*Procedure.*—Hand pollinations of blossoms are made in the orchards and the results studied.

*Location.*—Vicinity of Washington, D. C.

*Date begun.*—1890.

*Results.*—Important discoveries in self-sterility of fruits; improved methods of planting orchards to secure increased production by cross-pollination.

*Probable date of completion.*—The main project is already completed; certain points require further study.

*Assignment.*—M. B. Waite.

*Proposed expenditures, 1918-19.*—\$300.

#### **Apple Cankers of the United States:**

*Object.*—To determine the cause of and remedy for various apple cankers and to study the life history of the causal organisms.

*Procedure.*—Laboratory studies, both microscopical and cultural, are made of diseased material; field tests in eradication and control in orchards are conducted.

*Location.*—Washington, D. C., and apple orchards in various States.

*Date begun.*—1903.

*Results.*—Accumulation of data; practical experience in control; service to a large number of fruit growers.

*Assignment.*—M. B. Waite.

*Proposed expenditures, 1918-19.*—\$1,500.

#### **Apple Black Heart:**

*Object.*—To find the cause of this disease and develop a remedy or control methods. This disease blackens the inside of the trunks of young apple trees, causing premature decay and often death. It often causes serious damage in the Middle Western States.

*Procedure.*—Laboratory studies, including bacteriological culture work, are carried on; also field examinations in various orchards and nurseries.

*Location.*—Principally in the Middle Western States, Maryland, and Virginia; laboratory work at Washington, D. C.

*Date begun.*—1903.

*Results.*—Preliminary bacteriological researches have been made. Crown gall and other organisms have been found associated with the disease.

*Assignment.*—M. B. Waite, H. W. Truesdell.

*Proposed expenditures, 1918-19.*—\$300.

**(Apple and Peach Powdery Mildew:** Project completed. A practical method of control in the Watsonville, Cal., district by spraying with iron-sulphide mixture has been developed and the information published in Department Bulletin 120, "Apple Powdery Mildew and Its Control in the Pajarao Valley." This method has been modified to adapt it to the general irrigated orchard sections at Wenatchee, Wash., and a bulletin on the subject is now in press.)

**(Shot-Hole and Twig-Spot of Peaches and Apricots:** Discontinued as a separate project. A perfect spraying remedy has been found for the peach-gumming fungus, which was the principal disease being investigated under this project. The uncompleted portion will be carried on under "Miscellaneous Orchard Diseases.")

#### **Nut Diseases:**

*Object.*—To find causes of and remedies for various nut diseases, especially pecan diseases, and to develop control measures.

*Procedure.*—The usual laboratory and field investigations are carried on, the work being particularly concerned with a study of pecan diseases, the pecan rosette demanding especial attention; also an investigation of the diseases of the English walnut and filbert in the eastern United States and some control experiments on English-walnut diseases on the Pacific coast.

*Cooperation.*—Nut growers; Georgia State Board of Entomology.

*Location.*—Washington, D. C.; field work on pecan diseases, at Thomasville, Albany, and Cairo, Ga., and on English-walnut and filbert diseases in Virginia, Maryland, Delaware, Pennsylvania, and New Jersey.

*Date begun.*—1909.

*Results.*—A thorough study has been made of pecan scab and certain other fungous diseases, including methods of control, and remedies have been devised for certain pecan leaf diseases by spraying in the nursery and orchard. The knowledge of pecan disease is being rapidly built up. Extensive field experiments on pecan rosette have shown this disease to be physiological and due to soil conditions. Stable manure has been demonstrated to be an effective, though not always practical, remedy for these conditions.

*Assignment.*—S. M. McMurran, J. B. Demaree.

*Proposed expenditures, 1918-19.*—\$8,200.

#### **Root-Rot Diseases of Fruit Trees:**

*Object.*—To ascertain causes, life history, and methods of dissemination of the fungi responsible for root-rot diseases of fruit trees and to develop control or remedial measures.

*Procedure.*—This project involves laboratory work, including microscopical examinations and cultures; study of diseased trees in the orchards and of diseased nursery stock; inoculation tests and pathological investigations.

*Cooperation.*—Federal Horticultural Board and various horticultural inspectors over the country in the identification of material.

*Location.*—Washington, D. C. These diseases occur all over the United States.

*Date begun.*—1900.

*Results.*—Data and specimens accumulated but no remedy found as yet.

*Assignment.*—M. B. Waite.

*Proposed expenditures, 1918-19.*—\$1,000.

#### **Frost Injuries to Fruit Trees:**

*Object.*—To apply pathological methods to the study of frost injuries.

*Procedure.*—Frost injuries are followed up as they occur in different sections of the United States. The tissues are examined microscopically, and sometimes bacteriological cultures are made. Data and observations, drawings, and photographs of frost injuries and records of weather conditions which produce them are accumulated. Field studies are made on the behavior of fruit trees injured in varying degrees as frosts occur.

*Cooperation.*—Fruit growers, nurserymen, cold-storage houses, and fruit-tree inspectors.

*Location.*—Washington, D. C.; field work in orchards at various points.

*Date begun.*—1890



*Results.*—A better understanding of the injuries to fruit and fruit trees and of methods of handling frost-injured trees has been obtained.

*Assignment.*—M. B. Waite.

*Proposed expenditures, 1918-19.*—\$700.

### **Spraying Apparatus and Spraying Efficiency:**

*Object.*—To investigate in orchards the relative efficiency of the many types of spraying apparatus now on the market when in actual use in the control of diseases. Attention is given to the most economical types of spraying apparatus for given kinds of work and service. Estimates of spraying efficiency as practised by various orchardists, vineyardists, etc., are made as a basis for suggestions for improvements in such work.

*Procedure.*—Different types of spraying machinery in operation in orchards are observed to determine their comparative value and efficiency under varying orchard and farm conditions. In this connection observations are accumulated on the efficiency of the work as accomplished by different individuals, and special inquiries are made to determine wherein spraying operations do not give entirely satisfactory results in the control of diseases.

*Cooperation.*—This work is carried on in cooperation with the Bureaus of Entomology and Public Roads. The strictly engineering and mechanical work is conducted by the Bureau of Public Roads. Cooperative arrangements have been made between these three bureaus with reference to the conduct of this work.

*Location.*—Washington, D. C.; spray-apparatus factories and orchards and vineyards in various parts of the country.

*Date begun.*—Actually begun in 1886; taken up by the present leader in 1892; formulated as a joint cooperative project in 1915.

*Results.*—The work in past years has resulted in many detailed improvements, which have been utilized especially as suggestions to manufacturers and orchardists; information in Farmers' Bulletins 243, 284, 440, and 492.

*Assignment.*—M. B. Waite, John W. Roberts, C. L. Shear, H. R. Fulton.

*Proposed expenditures, 1918-19.*—\$500.

### **Fungicides for Fruit Diseases:**

*Object.*—To improve fungicides and methods of mixing them; to study their direct effect on fruits and fruit trees, especially their injurious effects and their efficiency in disease control; and to study combinations of fungicides with insecticides.

*Procedure.*—Experiments in mixing and compounding various fungicides are carried on in the laboratory and in the field, particularly in connection with field spraying experiments.

*Cooperation.*—Bureau of Entomology, Insecticide and Fungicide Board, Bureau of Chemistry, orchardists, and manufacturers of fungicides.

*Location.*—Washington, D. C.; field stations and orchards at Watsonville, Cal., Wenatchee and Vancouver, Wash., Bentonville, Ark., Vineland, N. J., and various other points.

*Date begun.*—Actually begun in 1886; taken up by the present leader in 1892.

*Results.*—Improvements are made annually in methods of mixing and applying fungicides and of combining them with insecticides.

*Assignment.*—M. B. Waite, C. L. Shear, Charles Brooks, John W. Roberts, W. S. Ballard, H. R. Fulton.

*Proposed expenditures, 1918-19.*—\$300.

### **Miscellaneous Orchard Diseases:**

*Object.*—To investigate various orchard diseases not covered by specific projects, including new diseases and those which suddenly assume importance.

*Procedure.*—The usual pathological methods are followed, including laboratory examinations, microscopic study, culture study, and field work.

*Cooperation.*—Fruit growers and horticultural inspectors.

*Location.*—Washington, D. C., and orchards over the United States.

*Date begun.*—1890.

*Results.*—Data have been accumulated about special diseases and service rendered to orchardists and to State and experiment station pathologists and horticultural inspectors through examination of specimens and



correspondence. In the case of apple cedar rust important practical benefits have been derived through the promotion of control by the destruction of the red cedars.

*Assignment.*—M. B. Waite, E. A. Siegler, L. M. Hutchins, H. W. Truesdell,  
*Proposed expenditures, 1918-19.*—\$3,675.

**Total, General Orchard Diseases, \$19,275.**

#### GRAPE AND SMALL-FRUIT DISEASES.

##### **Cranberry Diseases:**

*Object.*—To investigate the cause, improve control and preventive methods, and study the habits and life histories of the causative organisms, with special reference to the blossom-end rot, black-spot, ripe rot, and other recently discovered troubles.

*Procedure.*—This work includes spraying experiments, field studies of new or recently discovered diseases, especially blossom-end rot, and the trial of various methods of reducing loss from rot after harvesting. The relation of methods of picking and handling to the development of rot between picking and marketing is being studied.

*Cooperation.*—Massachusetts Experiment Station.

*Location.*—Washington, D. C., Arlington Farm, Va., Massachusetts, New Jersey, Oregon, and Washington.

*Date begun.*—1901.

*Results.*—Additional knowledge of the organisms causing disease, their distribution, habits, and methods of control has been accumulated. Treatment of bogs by flooding with copper-sulphate solution indicates benefit in the keeping qualities of the fruit.

*Assignment.*—C. L. Shear, N. E. Stevens, H. F. Bergman.

*Proposed expenditures, 1918-19.*—\$5,500.

##### **Grape Diseases:**

*Object.*—To determine the cause, discover or improve control methods, and study the life histories and habits of the causative organisms.

*Procedure.*—Spraying experiments and laboratory investigations are conducted, relative varietal resistance studied, and cross-inoculation experiments made.

*Cooperation.*—New Jersey Experiment Station.

*Location.*—Washington, D. C., Arlington Farm and Vienna, Va., and Vine-land, N. J.

*Date begun.*—1908.

*Results.*—Much additional knowledge of the organisms, their distribution, and control have been obtained.

*Assignment.*—C. L. Shear, R. B. Wilcox.

*Proposed expenditures, 1918-19.*—\$3,500.

##### **Diseases and Rots Developing in Picking, Packing, Transportation, and Marketing of Small Fruits:**

*Object.*—To determine the organisms and conditions causing loss in picking, packing, shipping, and marketing of small fruits and to develop methods for preventing such losses.

*Procedure.*—The work consists of laboratory studies of the organisms and other causes involved, field studies of methods of picking, handling, and shipping, and experiments in the control of the diseases or removal of the causes.

*Cooperation.*—Growers and shippers.

*Location.*—Washington, D. C., and various small-fruit growing centers and markets.

*Date begun.*—1915.

*Results.*—The effect of various methods of handling and shipping has been studied in Florida, Louisiana, and other States, showing that mechanical injury to fruit and high temperatures and lack of ventilation are the chief causes of deterioration and decay in transit and on the market. Several fungi causing rot in the field, especially in strawberries, have been isolated and studied.

*Assignment.*—C. L. Shear, N. E. Stevens, R. B. Wilcox, B. A. Rudolph.

*Proposed expenditures, 1918-19.*—\$3,500.



**Miscellaneous Small-Fruit Diseases:**

*Object.*—To study fungous and physiological diseases of raspberries, blackberries, blueberries, currants, gooseberries, and strawberries and methods of prevention or control.

*Procedure.*—Eradication and sanitary methods are followed, spraying experiments conducted, and laboratory and field studies made of the organisms and conditions causing disease.

*Cooperation.*—Small-fruit growers.

*Location.*—Washington, D. C., Arlington Farm and Vienna, Va., and Vine-land, N. J.

*Results.*—This work has been productive of increased knowledge of the life histories of the parasites and their importance, distribution, and control.

*Date begun.*—1906.

*Assignment.*—C. L. Shear, R. B. Wilcox, N. E. Stevens, Angie M. Beckwith.

*Proposed expenditures, 1918-19.*—\$3,000.

**Total, Grape and Small-Fruit Diseases, \$15,500.**

**CITRUS AND SUBTROPICAL FRUIT DISEASES.****Citrus Canker:**

*Object.*—To find the cause of this disease, study the life history of the causative organism, and develop methods of control and extermination.

*Procedure.*—The usual bacteriological and pathological studies in the laboratory and in the field are carried on.

*Cooperation.*—Federal and State officials and citrus growers and associations.

*Location.*—Florida and Gulf-coast States to Texas; Washington, D. C.

*Date begun.*—1914.

*Results.*—The distribution of the citrus-canker organism and its behavior in the field on various citrus hosts from Florida to Texas has been determined. The bacterial nature of the disease has been discovered and proved and a paper on the subject published in the Journal of Agricultural Research, vol. 4, No. 1, "Pseudomonas Citri, the Cause of Citrus Canker."

*Assignment.*—H. R. Fulton, Clara H. Hasse, H. A. Lee.

*Proposed expenditures, 1918-19.*—\$6,440.

**Miscellaneous Citrus and Subtropical Fruit Diseases:**

*Object.*—To find the causes of citrus and subtropical fruit diseases other than citrus canker, study the life histories of the organisms causing them, and develop methods for their control or extermination.

*Procedure.*—The usual pathological laboratory and field studies, including spraying experiments and tests of the effects of various methods of cultivation and fertilization on citrus diseases, are conducted.

*Cooperation.*—Citrus growers, mainly in Florida and the Gulf-coast districts.

*Location.*—Washington, D. C., temporary field laboratory at Orlando, Fla., and other points in Florida, and on the Gulf coast.

*Date begun.*—Under old Division of Pathology, in 1892; later in the subtropical laboratory at Miami, Fla.; transferred to Fruit Disease Investigations in 1908; present work actually inaugurated in 1912.

*Results.*—A preliminary study of citrus, pineapple, avocado, and mango diseases has been made, and experiments are now under way.

*Assignment.*—H. R. Fulton, J. R. Winston.

*Proposed expenditures, 1918-19.*—\$8,000.

**Total, Citrus and Subtropical Fruit Diseases, \$14,440.**

**ORCHARD SPRAYING EXPERIMENTS.****Apple Bitter-Rot and Blotch Investigations:**

*Object.*—To obtain further information regarding the life histories of the fungi causing these diseases, especially as to the manner of wintering; to perfect and improve methods of control by spraying and by eradication; to study the factors governing immunity and resistance.

*Procedure.*—This project involves pathological and mycological studies in the field and laboratory and tests of control methods by spraying and eradication.



*Location.*—Virginia, Maryland, Arkansas, Missouri, and Washington, D. C.

*Date begun.*—Bitter-rot, 1903; blotch, 1906.

*Results.*—A successful treatment has been found for both diseases by late summer spraying with Bordeaux mixture and, under unfavorable conditions, by eradicating all cankers, including minor cankers and dead twigs, in the winter. Data in Farmers' Bulletin 492, Department Bulletin 534, and Journal of Agricultural Research, vol. 4, No. 1, "Sources of the Early Infections of Apple Bitter-Rot."

*Probable date of completion.*—1920.

*Assignment.*—John W. Roberts.

*Proposed expenditures, 1918-19.*—\$2,300.

### **Peach and Plum Brown-Rot and Scab Investigations:**

*Object.*—To determine the life histories of the organisms concerned and better means for their control.

*Procedure.*—Field spraying experiments are conducted; also the usual pathological and microscopical studies in the field and laboratory.

*Cooperation.*—Bureau of Entomology.

*Location.*—Washington, D. C., New Jersey, Georgia, and Arkansas.

*Date begun.*—1904.

*Results.*—The treatment for brown rot and scab of peach has been perfected and good results obtained with these diseases on other stone fruits; data in Farmers' Bulletin 440.

*Probable date of completion.*—1922.

*Assignment.*—John W. Roberts.

*Proposed expenditures, 1918-19.*—\$950.

### **Apple Leaf Diseases:**

*Object.*—To work out the life histories and the causes of the various fungous spots on apple foliage; to study the immunity and resistance of different varieties.

*Procedure.*—Pathological and mycological studies of the diseased spots, are made, the various fungi isolated in pure cultures, and inoculation tests made to study the results; also field spraying tests in connection with other spraying work.

*Location.*—Washington, D. C., and various orchards in Virginia, Arkansas, and other parts of the eastern half of the United States.

*Date begun.*—1909.

*Results.*—Several leaf diseases have been differentiated and proof of their cause by various fungi established. Improved methods in the control of these diseases in the orchards have been worked out. Data in Farmers' Bulletin 492 and Journal of Agricultural Research, vol. 2, No. 1, "Experiments with Apple Leaf-Spot Fungi."

*Assignment.*—John W. Roberts.

*Proposed expenditures, 1918-19.*—\$700.

### **Peach and Plum Bacteriosis:**

*Object.*—To determine the nature of and remedy for the disease and the life history of the causative organisms.

*Procedure.*—Bacteriological laboratory studies are conducted, also field tests and experiments in eradication, spraying, and the use of special fertilizers.

*Location.*—Laboratory work at Washington, D. C.; in diseased orchards in Arkansas, Georgia, and other States.

*Date begun.*—1902.

*Results.*—Preliminary bacteriological investigations have been made. Nitrate of soda applied as fertilizer has been found to give control. Data in Department Bulletin 543.

*Assignment.*—John W. Roberts.

*Proposed expenditures, 1918-19.*—\$650.

### **Development of Orchard Spraying Methods.**

*Object.*—To develop routine systems of spraying, particularly against apple and peach diseases; to test the use of combination sprays of insecticides and fungicides and spraying schedules; to test and demonstrate the treatment in various sections where for any cause failure has occurred.



*Procedure.*—Field experiments in the orchards are carried on in various parts of the country.

*Cooperation.*—Bureau of Entomology.

*Location.*—Fort Valley, Ga., Anderson, Mo., Morrillton, Ark., and various other points in the United States. The location changes each year.

*Date begun.*—1906.

*Results.*—Combined spraying schedules for the apple and peach in various sections have been perfected.

*Assignment.*—John W. Roberts, Leslie Pierce.

*Proposed expenditures, 1918-19.*—\$1,200.

**Total, Orchard Spraying Experiments, \$5,800.**

#### FRUIT ROTS AND SPOTS.

(Fruit Spot of Jonathan and of Grimes and Other Yellow Apples: Discontinued as a separate project; included under "Fruit Spots and Scald of Apples.")

#### Fruit Spots and Scald of Apples:

*Object.*—To determine the nature of the diseases, their cause, and methods of prevention.

*Procedure.*—Irrigation and fertilizer experiments are conducted in the orchards and a particular study made of apples after they are picked and when in transit, in storage, and on the market.

*Location.*—Washington, D. C., Wenatchee, Wash., and various other points in the United States.

*Date begun.*—1912.

*Results.*—Some of the orchard and storage conditions which influence the amount of these diseases have been determined and methods of control reported.

*Assignment.*—Charles Brooks, J. S. Cooley, D. F. Fisher.

*Proposed expenditures, 1918-19.*—\$5,200.

#### Apple Bitter-Pit:

*Object.*—To determine the nature and cause of the disease and, as far as possible, methods of prevention.

*Procedure.*—Studies are made of the effect of nutrition, water supply, cultural methods, and various conditions of storage.

*Location.*—Wenatchee, Wash., Salem, Oreg., and various other points.

*Date begun.*—1909.

*Results.*—Data have been obtained that separate the disease from other closely-related troubles. Some of the orchard conditions which influence the development of the disease have been determined.

*Assignment.*—Charles Brooks, D. F. Fisher.

*Proposed expenditures, 1918-19.*—\$2,000.

#### Deciduous-Fruit Rot Investigations.

*Object.*—To determine the causes of and remedies for rots of deciduous orchard fruits; especially to study these rots after picking time and when in transit, in storage, and on the market.

*Procedure.*—The characteristics of the rots and the fungi causing them are being investigated from both mycological and physiological points of view. A study is being made of the fungi at various temperatures, both as to their growth on the fruit and their behavior on various culture media.

*Cooperation.*—Insecticide and Fungicide Board.

*Location.*—Washington, D. C., Arlington Farm, Va., Vancouver and Wenatchee, Wash., and Salem, Oreg.; storage work in various sections.

*Date begun.*—1888.

*Results.*—A large number of fungi have been isolated and their power to produce rots under various storage conditions determined.

*Assignment.*—Charles Brooks, D. F. Fisher, J. S. Cooley.

*Proposed expenditures, 1918-19.*—\$4,000.

(See also Supplement—Emergency Activities, p. 559.)

**Stigmonose of Deciduous Fruits:**

*Object.*—To study the pathological changes in the tissues of deciduous fruits produced by the punctures and sucking of insects; to distinguish between the spots resulting from insect punctures and the physiological bitter-pit.

*Procedure.*—Fruit is obtained that is known to be punctured by particular insects, and a general and microscopic study of the effects is made.

*Cooperation.*—Bureau of Entomology.

*Location.*—Washington, D. C., Vienna and Staunton, Va., and Wenatchee, Wash.

*Date begun.*—1907.

*Results.*—The disease has been more clearly set off from bitter-pit and other related troubles, and some insects that are of importance have been determined and the effects they produce studied.

*Assignment.*—Charles Brooks, D. F. Fisher.

*Proposed expenditures, 1918-19.*—\$400.

**Total, Fruit Rots and Spots, \$11,600.**

**PHYSIOLOGICAL FRUIT DISEASES.****Nutrition in Relation to Fruit Diseases:**

*Object.*—To determine the effect of soil and subsoil constituents on diseases, including a study of the relation of artificial ingredients in the soil to orchard diseases; to study the causes of certain unknown diseases suspected of being due to unfavorable environment.

*Procedure.*—Physiological and pathological methods are applied to the study of diseased orchards. The effects of climatic conditions, especially on the nonparasitic diseases, are studied. Investigation is made of soil conditions, chemical and mechanical, and the relation of soil moisture to certain diseases. The work involves both field and laboratory investigations.

*Cooperation.*—Fruit growers and horticultural commissioners and inspectors.

*Location.*—Washington, D. C., Watsonville, Cal., and field work mainly in the orchards of the semiarid and arid districts of the western United States.

*Date begun.*—1891.

*Results.*—Data accumulated regarding these little-known diseases; little-apricot trouble in Idaho identified as subsoil and irrigation difficulty; discovery made of the remarkable benefits of winter spraying with nitrate of soda in California and work extended to Washington and Oregon; paper in Journal of Agricultural Research, vol. 1, No. 5, "Winter Spraying with Solutions of Nitrate of Soda."

*Assignment.*—W. S. Ballard, E. M. Harvey.

*Proposed expenditures, 1918-19.*—\$3,500.

**Chlorotic Diseases of Fruit Trees:**

*Object.*—To discover the cause of and remedy for the various diseases of this class and to distinguish between the principal types.

*Procedure.*—The work includes laboratory and field investigations. Physiological and pathological methods are applied to the study of diseased orchards. The effect of climatic conditions on these diseases is studied. Soil and subsoil conditions, chemical and mechanical, and the relation of soil moisture to the diseases are investigated. Field investigation of the new disease known as "little leaf" of the peach in California, a supposedly physiological trouble, is under way.

*Cooperation.*—Orchardists and State and county horticultural commissioners.

*Location.*—Washington, D. C., Watsonville, Cal., and States west of the one-hundredth meridian; on peach little-leaf, San. Joaquin Valley, Cal.

*Date begun.*—1907.

*Results.*—Little is yet known about this difficult group of diseases; data accumulated as to nature and distribution of the maladies.

*Assignment.*—W. S. Ballard, E. M. Harvey.

*Proposed expenditures, 1918-19.*—\$3,000.

**Total, Physiological Fruit Diseases, \$6,500.**

**Total, Fruit-Disease Investigations, \$81,555, including \$5,620 statutory.**



## [Regulation.]

## ERADICATION OF CITRUS CANCKER.

**Eradication of Citrus Canker:**

*Object.*—To eradicate citrus canker, a very serious disease of oranges, lemons, grapefruit, and other citrus fruits.

*Procedure.*—Trees in the affected regions are inspected for the presence of citrus canker. Infected trees are located and burned as they stand, using oil spray. The burning is done by State officials under State authority.

*Cooperation.*—Cooperative arrangements have been made with the States of South Carolina, Florida, Georgia, Alabama, Mississippi, Louisiana, and Texas, whereby the department pays the salaries of inspectors, also traveling and other necessary expenses. Each cooperating State details a director to have local charge of the work and pays the salaries of the men engaged in burning infected trees and the expense of activities involving destruction of property under State laws.

*Location.*—Headquarters are maintained at Gainesville Fla., Atlanta, Ga., Auburn, Ala., Agricultural College, Miss., Baton Rouge, La. and Houston, Tex.

*Date begun.*—1915.

*Results.*—The cooperative campaign for the eradication of citrus canker is progressing very favorably. Reports indicate that the disease is under satisfactory control in South Carolina, Georgia, Alabama, and Florida, and its complete eradication throughout that area is perhaps to be expected during the present fiscal year. A somewhat longer time will probably be required for the completion of the work in the remaining States, although in those States also the progress of the work is encouraging.

*Assignment.*—K. F. Kellerman.

*Proposed expenditures, 1918-19.*—\$250,000.

## [Research.]

## INVESTIGATIONS IN FOREST PATHOLOGY.

## SUPERVISION.

**Supervision:**

*Object.*—To care for office and laboratory routine.

*Procedure.*—Maintenance of notes, records, maps, photographs, authorizations, audits, correspondence, files, and general office facilities; preparation of manuscripts; maintenance of culture-media supply and laboratory accommodations.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Assignment.*—Haven Metcalf.

*Proposed expenditures, 1918-19.*—\$10,100, including \$4,600 statutory.

## DISEASES OF SHADE AND ORNAMENTAL TREES AND SHRUBS.

**Diseases of Shade and Ornamental Trees and Shrubs:**

*Object.*—Investigation of these diseases with reference to control.

*Procedure.*—Studies are made of the life histories of the organisms causing these diseases; to improve, standardize, and evaluate methods of tree surgery, to determine varietal and specific resistance to disease, and to ascertain the distribution, extent, and annual occurrence of these diseases, with particular reference to their danger as possible epidemics.

*Cooperation.*—Department of Botany, Brown University.

*Location.*—Providence, R. I.

*Date begun.*—1907.

*Results.*—(1) Prior to 1918: Many demonstrations have been made of the best methods of tree surgery and disease control. Increased public use of the ginkgo and other resistant trees has resulted. About 60,000 inquiries for information along these lines have been answered. Two Government patents in tree surgery have been filed.

(2) During 1918: About 9,000 letters of information were prepared and sent to correspondents.

*Assignment.*—J. F. Collins.

*Proposed expenditures, 1918-19.*—\$5,400, including \$400 statutory.



## PATHOLOGICAL PROBLEMS IN WOOD CONSERVATION.

**Pathological Problems in Wood Conservation:**

*Object.*—To work out miscellaneous problems on the pathological aspects of wood conservation.

*Procedure.*—Studies are made of the specific toxicity of wood preservatives against certain timber-rotting fungi; of the causes, conditions, and means of control of decay in building timbers under yard and storage conditions, and in mining timbers; of the histology and cytology of wood rots in general; of the natural resistance of various species of wood to decay; and of the relation of moisture, temperature, and other surrounding conditions to decay.

*Cooperation.*—Forest Products Laboratory, Forest Service.

*Location.*—Madison, Wis.

*Date begun.*—1909.

*Results.*—(1) Prior to 1918: Definite knowledge has been obtained of the causes of certain types of decay of mining timbers, of the causes and conditions of various wood rots, and of the specific action of various preservatives. A method has been developed for quickly testing the toxicity of preservatives against pure cultures of wood-destroying fungi (method and tests published in Department Bulletin 227). About 5,500 such tests have been completed. A method of testing the toxicity of heavy oils has been invented. Studies of conditions surrounding structural timber in storage show that decay in storage is preventable by slight and perfectly practicable changes in lumber-yard management, as set forth in Department Bulletin 510. Practical results are reflected in work of the Forest Products Laboratory.

(2) During 1918: Full data have been secured on the temperature range of 73 species of wood-destroying fungi. About 500 tests of specific wood preservatives against pure cultures of wood-destroying fungi have been made.

*Assignment.*—C. J. Humphrey.

*Proposed expenditures, 1918-19.*—\$7,235, including \$400 statutory.

## FOREST-TREE DISEASES.

**Diseases of Forest Nursery Stock:**

*Object.*—Investigation of these diseases with reference to control.

*Procedure.*—This project involves the testing of the effects of various soil fungicides and amendments, of spraying, and of modifications of nursery practice on "damping-off" and other nursery diseases; also greenhouse and laboratory experiments on the life history of the parasites which cause "damping-off" and the factors affecting them, with a view to the development of new control methods.

*Cooperation.*—Forest Service and private nurserymen.

*Location.*—Field tests at Cass Lake, Minn., and Halsey and Nenzil, Nebr.; laboratory and greenhouse work at Washington, D. C.

*Date begun.*—1910.

*Results.*—(1) Prior to 1918: "Blight" of coniferous seedlings has been controlled by change in methods of watering. "Damping-off" on most soils, both in the East and West, has been controlled by treatment with sulphuric acid; amounts needed for a number of different localities have been determined. Treatment with copper sulphate has been developed in alkaline soils on which acid is not satisfactory. The weed destruction alone pays the cost of treatment at many nurseries. Part of the results are given in Department Bulletin 453. A disease similar to "damping off," but caused instead by excessive soil heat, has been studied, and the distinctive symptoms and preventive measures have been described in a manuscript now pending publication. The cause of the destructive nursery blight on cedars has been discovered, and the experimental work with it is described in the Journal of Agricultural Research, vol. 10, No. 10.

(2) During 1918: Investigations as to the causes of the "damping-off" disease of conifers have shown that at least seven distinct fungi are able to cause it. The identity of certain of the parasites with those causing diseases of crop plants has been demonstrated. Improvements in the sulphuric-acid control method have been discovered and are



being further tested to determine their adaptation to different soil types. Evidence has been obtained indicating the value of spraying in controlling the cedar blight.

*Assignment.*—Carl Hartley, Annie E. Rathbun.

*Proposed expenditures, 1918-19.*—\$7,615.

### **Cooperative Field Studies and Demonstrations in Forest Pathology:**

*Object.*—To determine the best methods of controlling forest-tree diseases, particularly in the national forests.

*Procedure.*—From detailed and statistical studies of diseased stands in typical areas, rotation and cutting cycles based on disease are established, improved marking and scaling methods developed, and exact percentages determined.

*Cooperation.*—Forest Service.

*Location.*—Missoula, Mont., Albuquerque, N. Mex., San Francisco, Cal., and generally throughout National Forest Districts 1, 3, and 5, and a few localities in District 6.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: The "sanitation clause" (Standard Clause No. 57, p. 30-S, National Forest Manual, Regulations and Instructions), which requires the purchaser in Government timber sales to cut all snags and all defective trees marked and to remove and pay for all merchantable lumber contained in such trees, has been developed by the work under this project. These studies also guide planting plans for the future forest in these particular localities, establish a definite cull percentage in place of an empirical one, and establish definite belts in which empirically found cull percentages may be more accurately applied. Studies of the pathology of the so-called inferior species show in the species so far studied that the inferiority is due to disease susceptibility. The age at which decay reaches practical importance (age of decline, critical age) is determined, which becomes a limiting factor in rotation (Department Bulletin 275). The discovery of a brush-rotting fungus (*Poria* sp.) and studies of its activities have led to the substitution of "pulling" brush for piling it in localities in Arizona, New Mexico, and Arkansas, where it is difficult to pile and burn on account of the shortness of the season during which burning is safe.

(1) During 1918: Work along the lines of the above results has been extended to additional diseases, species of trees, and localities. The studies on incense cedar are practically completed. In this species definite external symptoms of rot have been defined which enable the marker and scaler to determine the internal condition of tree and log without cutting, thus saving substantial expense.

*Assignment.*—E. P. Meinecke, Jas. R. Weir, W. H. Long.

*Proposed expenditures, 1918-19.*—\$14,650.

### **Miscellaneous Forest-Tree Diseases:**

*Object.*—Investigation, with reference to control, of the nature and life history of various tree diseases and of the effects of smelter fumes, smoke, and gases upon trees.

*Procedure.*—The usual methods of investigation of plant diseases are applied to forest-tree diseases.

*Cooperation.*—Forest Service.

*Location.*—Washington, D. C., Providence, R. I., Missoula, Mont., Albuquerque, N. Mex., and San Francisco, Cal.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: Fundamental contributions have been made to the knowledge of about 50 diseases.

(2) During 1918: A method of securing at will fruiting bodies of hymenomycetous fungi in culture has been devised (Journal of Agricultural Research, vol. 12, No. 2), which promises to be applicable not only to tree and timber rots but to all diseases caused by hymenomycetous fungi. Its immediate application lies in furnishing a means of identifying unknown wood rots which present no fruiting bodies.

*Assignment.*—Geo. G. Hedgcock, E. P. Meinecke, Jas. R. Weir, W. H. Long, J. Franklin Collins.

*Proposed expenditures, 1918-19.*—\$6,975.

**Total, Forest-Tree Diseases, \$29,240, including \$1,240 statutory.**



## IMPORTED AND EPIDEMIC TREE DISEASES.

**Miscellaneous Imported and Epidemic Tree Diseases:**

*Object.*—Investigation of the white-pine blister rust, the chestnut bark disease, the pitch-pine blister rust, the European-poplar canker, and other imported and epidemic tree diseases, with reference to their control.

*Procedure.*—In the course of work under other projects attention is called to these diseases. Their life histories are then studied to find weak points for attack, and their range, origin, and means of spread are determined. Under this project the fundamental problems of spread and adaptation of introduced diseases and the problems of susceptibility of native tree species to foreign diseases are studied.

*Cooperation.*—Federal Horticultural Board; also informal cooperation with States, private firms, and individuals.

*Location.*—Washington, D. C., Providence, R. I., and various field points throughout the United States.

*Date begun.*—1907.

*Results.*—(1) Prior to 1918: The real nature and Asiatic origin of the chestnut bark disease and its manner of distribution have been determined. Many new facts have been discovered regarding the relation of meteorological conditions to this disease. Extensive destruction of advance infections has been accomplished, which is estimated to have retarded the advance of the disease 15 years. The practical utilization of disease-killed trees has been made possible. Resistant and immune Asiatic strains have been discovered. A chinquapin-Japanese chestnut hybrid resistant to the chestnut bark disease has been developed and is being propagated. Eleven newly imported diseases have been studied and destroyed so far as found. New and decisive methods, involving new symptoms, have been discovered for identifying doubtful cases of white-pine blister rust. All native *Ribes* tested (about 70 species) have been found susceptible to blister rust. The blister rust has been shown to be apparently taking on new characters and to be apparently more virulent in America than in Europe. The work done under this project has resulted in a marked change in the public attitude toward these diseases, involving general recognition of the dangers of importation of ornamental and forest-tree nursery stock.

(2) During 1918: Many new facts regarding the life history of the parasite causing the white-pine blister rust have been discovered. A case of overwintering of the disease on *Ribes* has been observed, also wood infections on *Ribes*. The rust on *Ribes* in Colorado, at first believed to be the white-pine blister rust, has been shown to be a relatively harmless native rust, with its alternate stage on pinon pine.

*Assignment.*—Haven Metcalf, Perley Spaulding, Reginald H. Colley, Minnie W. Taylor.

*Proposed expenditures, 1918-19.*—\$40,300, including \$2,000 statutory.

**Total, Investigations in Forest Pathology, \$92,275, including \$8,640 statutory.**

[Regulation.]

**CONTROL OF WHITE-PINE BLISTER RUST.****Control of White-Pine Blister Rust:**

*Object.*—To control the white-pine blister rust.

*Procedure.*—Local control areas are established in regions where *Ribes* infection is general. Wild and cultivated *Ribes* are destroyed in these areas in cooperation with and under legal authority of the States concerned. Specially selected demonstration areas are used to determine the most efficient methods, cost, and practicability of wild *Ribes* eradication. Eradication of beds of skunk currant and dense wild gooseberry growth by means of various chemicals is being undertaken in a small way. Shipments and reshipments of 5-needle pine stock from foreign and domestic nurseries, known or suspected of being infected, are traced and inspected. When the disease is found, the diseased trees, and near-by *Ribes* when necessary, are destroyed by the appropriate State officials; when legally or otherwise possible, the entire shipment is destroyed. Systematic scouting for diseased pines and *Ribes* also is



conducted outside the region of general infection wherever there is a possibility that "spot infections" of the blister rust exist. Eradication of these secondary infections is attempted by removal of all pines or Ribes, or both, if necessary, under State authority.

*Cooperation.*—Formal or informal cooperation has been established with all States except Florida, Alabama, Mississippi, and Louisiana, where there are no 5-needle pine interests. In the New England States, New York, Pennsylvania, Wisconsin, and Minnesota, Ribes eradication is done on the basis of one dollar spent from Federal funds for each dollar spent by State and town authorities in control work. In all cases eradication is done under State authority, the Bureau of Plant Industry assuming responsibility only for locating the disease.

*Location.*—The work is conducted wherever the white-pine blister rust occurs or is suspected to be present, particularly throughout the range of 5-needle pines. Inspection of nursery stock and plantations is carried on chiefly in New Jersey, Pennsylvania, Delaware, Maryland, the southern Appalachian region, the Middle West, and the Far West. Eradication of advance infections is being done in the Lake States and western New York. Local control and demonstration Ribes eradication areas are located in the New England States and northeastern New York.

*Date begun.*—1916.

*Assignment.*—S. B. Detwiler, Roy G. Pierce, J. F. Martin, George L. Barrus, A. B. Brooks.

*Proposed expenditures, 1918-19.*—\$234,048, including \$3,600 statutory.

#### [Research.]

### COTTON, TRUCK, AND FORAGE CROP DISEASE INVESTIGATIONS.

#### SUPERVISION.

##### Supervision:

*Object.*—To provide for the administrative, clerical, and routine laboratory work necessary for the proper conduct of the research and extension projects.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—W. A. Orton.

*Proposed expenditures, 1918-19.*—\$16,760, including \$10,120 statutory.

#### COTTON DISEASES.

##### General Investigations of Cotton Diseases:

*Object.*—To study cotton diseases, discover preventive or remedial treatment, and breed resistant varieties, especially early, big-bolled, wilt-resistant varieties adapted to boll-weevil conditions in the eastern part of the cotton belt and long-staple, wilt-resistant varieties.

*Procedure.*—General observations and field surveys are made to determine the prevalence and distribution of cotton diseases; general pathological work is carried on in the Washington laboratory; and resistance breeding is conducted on plats of infected land rented from farmers.

*Location.*—Florence, Monetta, and Fairfax, S. C., Americus, Ga., and Washington, D. C.

*Date begun.*—1899.

*Results.*—(1) Prior to 1918: Successful methods for breeding wilt-resistant cotton were worked out. Two satisfactory short-staple, upland types were produced and introduced into cultivation. Three promising new early, big-bolled, wilt-resistant strains were bred, tested under boll-weevil conditions, and their propagation for distribution begun. These hybrids rank among the first in resistance, earliness, and yield in comparison with the best resistant and nonresistant varieties. The fact was definitely established that cotton wilt is not transmitted by the seed. Preliminary work was done on the control of cotton root-rot.

Publications issued: Division of Vegetable Pathology and Physiology Bulletin 27; Farmers' Bulletins 302, 333, 555, 625, and 787; Bureau of Plant Industry Bulletin 105, Part 2; and B. P. I. Circulars 9 and 92.



(2) During 1918: The Dixie cotton has continued to grow in popular favor, as shown by the reports from farmers and the demand for seed. The breeding of the new early, big-bolled, wilt-resistant strains has made steady progress. They have maintained their wilt resistance and their superiority in earliness, length of staple, and yield, and quantities of seed sufficient to supply a number of cooperative breeders have been produced. A revision of Farmers' Bulletin 625, "Cotton Wilt and Root Knot," was issued.

*Assignment.*—L. O. Watson.

*Proposed expenditures, 1918-19.*—\$3,378.

### **Cooperative Wilt-Resistant Cotton and Cowpea Breeding:**

*Object.*—To provide for the production of sufficient quantities of disease-resistant cotton and cowpea seed to supply the needs of all growers in wilt-infected districts.

*Procedure.*—The project leader works with a collaborator in each State to train plant breeders, guide them in their methods, and stimulate the production of pure strains of the resistant varieties originated by the department. Yearly tests of the strains of wilt-resistant cotton grown by the different breeders, in comparison with the best commercial varieties, are conducted at several points in the different States.

*Cooperation.*—Alabama Agricultural Experiment Station; informal cooperation with growers.

*Location.*—Florence, S. C., Auburn, Ala., and other points in these States.

*Date begun.*—1911.

*Results.*—(1) Prior to 1918: The work was thoroughly organized in South Carolina, Georgia, and Alabama. The Georgia work was taken over by the State in 1915. In South Carolina a large number of cooperative breeders were instructed in methods for producing and maintaining pure strains of wilt-resistant cotton and disease-resistant cowpeas. Large quantities of seed were produced under departmental supervision for sale to farmers. Similar work was begun in Alabama. The quality of the seed was improved each year, as shown by the variety tests. Special early strains of Dixie were selected for growing under boll-weevil conditions. Reports from growers of Dixie showed large savings effected by its use.

(2) During 1918: During the past year this work has been attended with great success. The cooperative breeders and growers planted a larger acreage and produced more pedigreed seed than in any previous year. The amount of seed offered for sale has increased from 1,100 bushels in 1912 to 11,130 bushels last season. It is conservatively estimated that at least half the loss formerly due to cotton wilt in South Carolina is now being avoided through the planting of the resistant varieties on infected land. The Dixie is more extensively grown than all the other varieties combined and continues to prove highly satisfactory. The disease-resistant varieties of cowpeas are proving their value wherever grown and are rapidly gaining in popular favor. The demand for seed has been greatly in excess of the amount produced. A larger acreage was planted last year than in any previous year.

*Assignment.*—L. O. Watson, H. B. Tisdale.

*Proposed expenditures, 1918-19.*—\$4,372.

**Total, Cotton Diseases, \$7,750.**

(See also Supplement—Emergency Activities, p. 555.)

### **TRUCK-CROP DISEASES.**

#### **Potato Diseases:**

*Object.*—To discover causes and methods of prevention or control of the more important potato diseases, particularly those involved in the interstate seed industry and those presenting difficult problems requiring long-continued investigations, collaboration of several specialists, and experimentation in different States; also those relating to Federal quarantines.

*Procedure.*—The general pathological studies are carried on in the Washington laboratory and at field stations. The potato diseases transmitted by seed tubers, those resulting from unbalanced fertilizer conditions, and those causing decay in storage and transit are given special attention. In general, the investigations are of an exhaustive or monographic character and are carried out from a national standpoint. Results of local



application are made available to the States through the extension organization.

*Cooperation.*—Experiment stations of Maine and Colorado, the College of Agriculture of Cornell University, and Board of County Commissioners of Weld County, Colorado; the Bureau of Chemistry cooperates in spraying experiments for the testing of different fungicides.

*Location.*—Presque Isle, Me., Greeley, Colo., Ithaca, N. Y., Washington, D. C., Arlington Farm, Va., and other points.

*Date begun.*—1908.

*Results.*—(1) Prior to 1918: Field stations were established and fully equipped in Idaho, Colorado, and Maine. The manner of overwintering of late blight was discovered and a method for testing the resistance of varieties to this disease worked out. Several new diseases, including leaf-roll, curly-dwarf, mosaic, and others, were found to be the cause of serious loss, and it was shown that these are largely preventable through seed selection. The causes of several storage tuber rots were determined and practical control measures found. Considerable data relative to the life history of the powdery-scab fungus were secured, its distribution learned, and the factors limiting its occurrence determined. It was proved that organisms causing potato diseases are present in desert soils, and methods for producing healthy crops on such soils were worked out. Monographic studies of the genus *Fusarium* were completed. The cause and practical means of control for potato leak were discovered. Investigations were begun on a new disease associated with lack of potash. Laboratory studies on the behavior of different strains of *Rhizoctonia* were completed. A plan for State inspection and certification of seed potatoes was worked out. The following publications were issued: Bureau of Plant Industry Bulletin 245, Farmers' Bulletins 544 and 489, Bureau of Plant Industry Circulars 23 and 52, a separate from Bureau of Plant Industry Circular 127 on "Silver Scurf, a Disease of the Potato," Department Bulletins 47, 64, 81 and 82, and various articles in the Journal of Agricultural Research.

(2) During 1918: Good progress has been made in the study of Western potato diseases, and the results indicate that a reduction in loss may be brought about by rotation of crops, seed selection, and good cultural methods. A paper on *Fusarium* wilt is ready for publication. Tests of various fungicides in the control of late blight have shown that to date standard Bordeaux mixture is the most effective. The disease due to lack of potash has been further investigated, and it has been shown that where potash is not available the disease may be held in check by the use of stable manure. Studies of potato stem lesions have shown that the type of injury heretofore thought to be caused by *Rhizoctonia* may also be caused by several species of *Fusarium*. The bacterial soft rots of potatoes have been studied, their causes determined, and the conditions favoring their development and means for their prevention ascertained. Progress has been made in the study of leaf-roll and considerable information regarding its occurrence and cause obtained. A study of the action of common potato decay-producing organisms on potato starch has shown that neither freezing nor decay results in the destruction of starch and that affected shipments arriving at terminal markets can profitably be salvaged for their starch content. The following publications have been issued: Farmers' Bulletin 868, Department Bulletin 577, and articles in the Journal of Agricultural Research, vol. 8, No. 7, and vol. 9, No. 12.

*Assignment.*—H. A. Edson, H. G. MacMillan, E. S. Schultz, L. O. Kunkel, M. Shapovalov, W. B. Clark, L. O. Hawkins, G. B. Ramsey, Ernst Artswager.

*Proposed expenditures, 1918-19.*—\$26,090.

(See also Supplement—Emergency Activities, p. 555.)

**(Potato Seed Inspection and Certification:** Discontinued as a separate project; included under "Potato Diseases.")

### Sweet-Potato Diseases:

*Object.*—To study the several sweet-potato diseases and discover practical means of control.

*Procedure.*—Thorough pathological studies are made in the Washington laboratory and at Arlington Farm, control methods tested in farmers'



hotbeds and fields, and general surveys of the country conducted to determine the occurrence and prevalence of the diseases. Investigations of storage rots are emphasized, with a view to secure the preservation of the crop harvested.

*Cooperation.*—Virginia Truck Experiment Station; informal cooperation with farmers in New Jersey and Virginia.

*Location.*—Washington, D. C., Vineland, N. J., Norfolk and Tasley, Va., and Arlington Farm.

*Date begun.*—1911.

*Results.*—(1) Prior to 1918: The dry-rot, stem-rot, and foot-rot diseases were investigated and the results published. It was discovered and demonstrated that black-rot, stem-rot, foot-rot, and scurf can be successfully controlled by seed selection, seed treatment, use of disease-free hotbeds, and rotation of crops. The various storage rots were differentiated and studied with particular reference to the relation of temperature and humidity to their development. The occurrence and distribution of sweet-potato diseases was determined by surveys. Attempts to select strains resistant to disease have shown that this method of control is not practicable. Data in Farmers' Bulletin 714 and Journal of Agricultural Research articles, vol. 1, No. 3, and vol. 5, No. 17.

(2) During 1918: Additional experimental work on the control of stem-rot, black-rot, foot-rot, and scurf have confirmed the results of previous years. The laboratory work on the storage-rot organisms has been completed and the data put in form for publication. It was found that the range of temperature is the governing factor in the extent of loss from storage rots, that humidity is a controlling factor in infection, and that, if a temperature of 50° to 55° and a relatively low humidity are maintained, loss can be prevented. A new form of surface rot, which is becoming increasingly important each year in the northern sections, has been studied.

*Assignment.*—L. L. Harter, J. L. Weimer, L. E. Barrett.

*Proposed expenditures, 1918-19.*—\$5,785.

(See also Supplement—Emergency Activities, pp. 555-556.)

**(Malnutrition of Truck Crops:** Discontinued as a separate project; included under "Miscellaneous Truck-Crop Diseases.")

### **Breeding Rust-Resistant Asparagus:**

*Object.*—To secure improved strains of asparagus immune to the rust disease.

*Procedure.*—All obtainable varieties of asparagus were subjected to field infection and from one, Reading Giant, resistant individuals were selected and crossed, their progeny compared, and the most desirable breeding stock isolated. These strains are improved from year to year and the supply of seed and roots grown for distribution is increased.

*Cooperation.*—Massachusetts Experiment Station and Massachusetts Asparagus Growers' Association.

*Location.*—Washington, D. C., Arlington Farm, Va., Concord, Mass., and Hartsville and Monetta, S. C.

*Date begun.*—1906.

*Results.*—(1) Prior to 1918: Rust-resistant strains of better quality than any commercial varieties were produced, the new method of breeding being also applicable to improvement in quality and yield. Isolated fields of seed-producing pedigreed strains were established to provide stock for distribution. A considerable quantity of seed and several thousand roots were distributed. Tests of the new strains by growers in different localities gave highly satisfactory results. Bureau of Plant Industry Bulletin 363 was published.

(2) During 1918: The breeding work for the further improvement of the rust-resistant variety has been continued with good results, and early and late strains to fill the needs of growers who wish to meet different market conditions have been produced. Additional pedigreed roots were grown to plant new seed fields and the distribution of seed and roots increased.

*Assignment.*—J. B. Norton.

*Proposed expenditures, 1918-19.*—\$3,320.



**Cucumber Diseases:**

*Object.*—To study the diseases of cucumbers, especially those causing losses in the pickle-growing sections; to develop and test methods for their control; and to determine the effect of fungicides on the setting of cucumber fruits.

*Procedure.*—Pathological studies are conducted in Washington and at field laboratories in three States where the heaviest losses occur. Spraying experiments and field tests of control methods are also conducted at these stations on land furnished by a commercial pickling firm.

*Cooperation.*—The experiment stations of Wisconsin, Michigan, and Indiana, a commercial pickling company, and the Bureau of Entomology.

*Location.*—Washington, D. C., Madison, Wis., Big Rapids, Mich., and Plymouth, Ind.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: Valuable data were accumulated regarded the best fertilizers, varieties, and date and distance of planting in their relation to disease occurrence; studies of the organisms causing scab, anthracnose, and angular leaf-spot were made; "white pickle" was discovered to be a mosaic disease, its method of dissemination determined, and progress made toward the working out of methods of control; considerable information was secured regarding the best fungicides for disease control and the effect of spraying on the yield of cucumbers; and the distribution and prevalence of cucumber diseases in the Middle West was learned by surveys. The Bureau of Entomology cooperated by conducting work on insects responsible for injury to the cucumber crop and concerned in the transmission of cucumber diseases.

(2) During 1918: The results of the third season's spraying experiments confirm those of previous years, showing some disease control but only very small gains in yield, and lead to the conclusion that with cucumbers grown for pickling purposes in the Middle West spraying does not pay in most years except in case of the occurrence of downy mildew. It has been proved that angular leaf-spot certainly and anthracnose probably are carried over winter on the seed. Field tests of seed treatment with mercuric chloride 1-1000 for five minutes as a means of control for these diseases were very successful, and this method is now being recommended. It has been thoroughly demonstrated that anthracnose, angular leaf-spot, and scab overwinter in the soil on diseased vines and that crop rotation is one of the most important means of control. Further discoveries relative to the transmission and overwintering of mosaic have been made and further tests of control methods conducted. The Bureau of Entomology has continued to assist in this work. The cucumber-disease surveys were extended to Colorado, Iowa, and other Western States.

*Assignment.*—W. W. Gilbert, M. W. Gardner, W. N. Ankeney.

*Proposed expenditures, 1918-19.*—\$4,750.

**(Cabbage Diseases:** Discontinued as a separate project; included under "Miscellaneous Truck-Crop Diseases.")

**Nematode Diseases of Truck Crops:**

*Object.*—To investigate the diseases of truck and forage crops and related plants caused by parasitic nematodes and to discover and apply methods for their control.

*Procedure.*—Laboratory and greenhouse studies of parasitic eelworms, their life history and method of attack, are made in the Washington laboratory. Field experiments with control measures, especially crop rotations, are conducted. A special campaign for the eradication of root-knot is in progress, and efforts are being made to free the department propagating gardens in Florida and Maryland from this trouble.

*Cooperation.*—South Carolina Experiment Station.

*Location.*—Washington, D. C., Florence, Sumter, and Monetta, S. C., Brooksville, Fla., Yarrow, Md., and Laredo, Tex.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: Valuable data were secured through laboratory studies of the various parasitic nematodes. General outlines of farm methods of control were determined. Successful control of the



root-knot nematode in dasheens was secured by the hot-water treatment. Rotation experiments were begun. Tests of varieties of cotton for resistance to root-knot indicated the possibility of the development of strains highly resistant to this disease. Progress was made in freeing the plant introductions of nematode infection. Detailed surveys were made of one county in South Carolina and two counties in Florida and the amount of loss due to root-knot of cotton and truck crops determined. Bureau of Plant Industry Bulletin 217 and Farmers' Bulletin 648 were published.

(2) During 1918: The work of the past season has been mainly a continuation of experiments already under way, and the results have confirmed those of previous years. The crop-rotation experiments of root-knot resistant cotton has continued to give gratifying results; the testing of various legumes for resistance to root-knot was begun; and the hot-water method of control for root-knot in dasheens was tried out on a field scale with entirely satisfactory results. Experiments were begun to determine the relation of certain legumes to the root-knot nematode under the soil and climatic conditions obtaining in the irrigated sections along the border of Texas and Mexico. The results to date show that the resistant varieties of cowpeas maintained their resistance and that all varieties of velvet beans were also resistant. Other legumes yielded significant results. Field work was begun to determine the relation of temperature to the distribution, quantity, and activity of nematodes.

*Assignment.*—L. P. Byars, Hallie Marvin.

*Proposed expenditures, 1918-19.*—\$3,500.

(See also Supplement—Emergency Activities, pp. 555-556.)

### **Tomato Diseases:**

*Object.*—To discover successful methods for the control of tomato diseases, particularly leaf and fruit spots and the wilt diseases; to breed resistant varieties, and to study new diseases of the tomato.

*Procedure.*—Pathological studies and spraying tests are conducted in the Washington laboratory, at Arlington Farm, and at a field station in Florida. Breeding for disease resistance and the control of leaf and fruit spots by spraying are important phases of the work. Other means of control are tested.

*Cooperation.*—Maryland, New Jersey, and Virginia experiment stations, and truck-growers' associations in Florida.

*Location.*—Washington, D. C., Arlington Farm, Va., Hurlock, Md., Salem, Va., Paoli, Ind., Moorestown, N. J., and Miami, Fla.

*Date begun.*—As a separate project, 1917.

*Results.*—(1) Prior to 1918: The breeding and testing of strains of tomatoes resistant to the Fusarium wilt disease was successfully inaugurated. All the important commercial varieties and wilt-resistant strains bred by the Maryland and Louisiana experiment stations were tested on infected soil and selections made for resistance. From these several promising strains were secured and propagated for testing. Additional selections were made from local varieties on badly infected fields in New Jersey last season. Experiments were undertaken to work out spray formulas and spray methods for the successful control of Septoria leaf-spot of tomatoes, and a study of the organism causing the disease was made. Preliminary studies of the tomato diseases prevalent in the Florida trucking sections were made.

(2) During 1918: Tests of the Fusarium wilt-resistant selections from the Stone variety made in several States have given favorable results, showing them to be resistant to the wilt under varying conditions and of good quality. A considerable quantity of seed was produced which is being more widely tested this year. Other resistant varieties adapted to different market requirements have been produced and are being multiplied for distribution, and the breeding work is being continued. Septoria leaf-spot has been successfully controlled by the application of special spray formulas and improved methods. The formula which has given the most conclusive results is being introduced into general use this season, and other more promising ones are being tested further. Excellent progress has been made in the study of the Phoma and Alternaria fruit-spots, the Rhizoctonia ground-rot, and other troubles in Florida and in the testing of methods for their control.



*Assignment.*—F. J. Pritchard, J. Rosenbaum, W. B. Clark, Wm. S. Porte.  
*Proposed expenditures, 1918-19.*—\$8,000.  
 (See also Supplement—Emergency Activities, pp. 555-556.)

### Watermelon Diseases:

*Object.*—To study new diseases of watermelons, particularly the *Diplodia* stem-end rot and other troubles causing losses in transit to market, and to discover the best practical methods of control for all the important diseases of this crop.

*Procedure.*—Studies of the stem-end rot organism are being completed at the Laboratory of Cryptogamic Botany, Harvard University, and at temporary field stations. Field studies on the transmission of anthracnose on the seed are in progress, and spraying experiments for control of anthracnose are conducted.

*Cooperation.*—Harvard University; informal cooperation of melon growers.

*Location.*—Cambridge, Mass., and Miami and Monticello, Fla.

*Date begun.*—As a separate project, 1917.

*Results.*—(1) Prior to 1918: Studies to determine the causes of deterioration of watermelons in transit to market were begun in 1915 and led to the discovery that a rot originating in the field and caused by the *Diplodia* fungus was responsible for much of the loss. Anthracnose injury was also found in a smaller percentage of shipments. The laboratory studies and field experiments resulted in the working out of practical methods of control for both these diseases. Data published in Farmers' Bulletin 821 and in the Journal of Agricultural Research, vol. 6, No. 4.

(2) During 1918: The control methods for *Diplodia* end-rot and anthracnose were further tested and demonstrated to the farmers. A field station was maintained at Macon, Ga., and experimental fields were located at other points in central and south Georgia. Field sanitation and the application of a disinfectant paste to the cut stems of melons while loading again proved successful in the control of *Diplodia* end-rot, and spraying with Bordeaux mixture for control of anthracnose was also effective. Several different formulas were tested. Laboratory studies to determine the nature of the *Diplodia* fungus have been continued.

*Assignment.*—F. C. Meier.

*Proposed expenditures, 1918-19.*—\$5,000.

### Bean Diseases:

*Object.*—To investigate the important diseases of beans and to discover and demonstrate practical methods for their control, including the propagation and dissemination of disease-free and disease-resistant seed.

*Procedure.*—New bean diseases are studied in the laboratory and field as the need arises. For the present, emphasis is being placed on control measures for anthracnose and bacterial blight, and a special effort is being made to locate supplies of disease-free and disease-resistant seed of the varieties commonly grown and to place these with seed breeders and seed growers who will increase the stocks under departmental supervision and make their crops available to the farmers.

*Cooperation.*—Saginaw County Farm Bureau, Saginaw, Mich., and Cornell University, Ithaca, N. Y.

*Location.*—Washington, D. C., Saginaw, Mich., Ithaca, N. Y., and other points in the bean-growing States.

*Date begun.*—1917.

*Assignment.*—M. F. Barrus, G. A. Meckstroth, W. H. Burkholder.

*Results.*—The results of the first season's work relate principally to the control of anthracnose. A field station was established at Goodells, Mich., for the conduct of this work. Three principal means of control are being developed: (1) The production of eastern-grown disease-free seed through the careful elimination of infected plants. A considerable quantity of disease-free seed of three popular varieties was grown last season and a beginning made with a number of other commercial varieties. (2) The use of seed grown in the irrigated sections of the West where anthracnose does not occur. About 200 bushels of Navy pea and 15 bushels of Refugee wax-bean seed were produced last year in Idaho and Colorado for testing in the East this season. Previous tests of such seed have given favorable results. (3) The development of resistant varieties. One satisfactory resistant strain of Red Kidney has been developed and is being multiplied. A bean-disease survey in Michigan, New York, and Vermont



resulted in the location of a considerable number of disease-free fields, and steps were taken to insure the sale of these crops for seed purposes. Anthracnose and bacterial blight, as well as other diseases, such as root rots and mosaic, caused heavy losses in some sections last season. A study of foot-rot disease is in progress.

*Proposed expenditures, 1918-19.*—\$8,000.

(See also Supplement—Emergency Activities, pp. 555-556.)

### Miscellaneous Truck-Crop Diseases:

*Object.*—To determine the causes of truck-crop diseases and find methods for their suppression and control.

*Procedure.*—This project includes the necessary work done on lesser problems and on suspended or nearly closed projects and the identification of material received at Washington from correspondents. It involves mainly laboratory work in Washington with some field trips to meet emergency calls.

*Cooperation.*—State experiment stations.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—(1) Prior to 1918: Numerous diseases identified and correspondents advised regarding treatment. A tomato fruit-rot caused by *Phoma destructiva* was worked out; two wilt diseases of okra differentiated and their causes determined; the causes and methods of control determined for all the most important ginseng diseases; preliminary work done on tomato and watermelon diseases as reported under those projects; laboratory studies of the organisms causing storage rots of dash-eens and other economic aroids completed and the results published; preliminary field investigations made of two new lettuce diseases causing losses in Texas and South Carolina; studies of a *Phoma* disease of okra begun; malnutrition troubles studied and found to be controllable by liming the soils and filling them with humus; a disease of spinach thought to be due to malnutrition shown to be a mosaic trouble; work begun on the breeding of strains of spinach resistant to disease. Preliminary work was done to extend to other States the breeding of yellows-resistant cabbage begun by the Wisconsin Station. Data published in Farmers' Bulletins 488 and 736, in Journal of Agricultural Research separates, vol. 2, No. 5, vol. 4, No. 1, vol. 6, No. 15, vol. 5, No. 4, and vol. 5, No. 7, and in Bureau of Plant Industry, Bulletin 250.

(2) During 1918: Investigations were begun on a disease of rhubarb which was found to be causing considerable loss in a number of States. Root diseases of peas, a blight of salsify, and other miscellaneous truck-crop diseases have received preliminary study. The investigations of the *Phoma* pod-spot disease of okra have been completed and the results prepared for publication. An important pod-blight of the Lima bean has been worked out and the results published. The method of transmission and overwintering of spinach mosaic has been discovered, a basis established for the working out of control measures, and a publication prepared. Strains of spinach which show considerable resistance to spinach blight have been bred. Publications issued: Farmers' Bulletin 856 and 925 and Journal of Agricultural Research separates, in vol. 11, No. 10, and vol. 12, No. 9.

*Assignment.*—W. A. Orton, Wm. N. Ankeney, L. P. Byars, H. A. Edson, W. W. Gilbert, G. H. Godfrey, L. L. Harter, L. O. Kunkel, H. G. MacMillan, G. A. Meckstroth, F. J. Pritchard, J. Rosenbaum, E. S. Schultz, M. Shapovalov, J. L. Weimer, Ruth F. Allen.

*Proposed expenditures, 1918-19.*—\$7,805.

**Total, Truck-Crop Diseases, \$72,250, including \$2,640 statutory.**

### FORAGE-CROP DISEASES.

#### Forage-Crop Diseases:

*Object.*—To study diseases of forage crops, especially alfalfa, clover, and cowpeas, work out control measures, and breed resistant varieties.

*Procedure.*—The organisms causing forage-crop diseases are studied in the Washington laboratory, and experiments are carried on in field plots. Surveys are made to determine the prevalence and distribution of forage-crop diseases. Disease-resistant cowpea breeding is conducted in field plots in the South, and general conditions governing disease resistance in other legumes are studied.



*Location.*—Washington, D. C., Chico, Cal., Monetta, S. C., and Madison, Wis.

*Date begun.*—1900.

*Results.*—(1) Prior to 1918: Identifications have been made of miscellaneous diseases received from time to time; causes and control measures for many diseases of cowpeas determined; wilt and root-knot resistant varieties of cowpeas produced, introduced into cultivation on infected land, and their value in the control of these diseases demonstrated; investigations of the yellow leaf-blotch of alfalfa and the leaf-spots of alfalfa and clover begun and a means of control for one of the leaf-spots by seed sterilization worked out; surveys made to determine the prevalence and distribution of alfalfa and clover diseases.

(2) During 1918: Studies of the yellow leaf-blotch of alfalfa have been completed and the results prepared for publication. This disease is increasing in prevalence and has become probably the most important of the foliage troubles. On the basis of the work completed, recommendations for control can be made that will undoubtedly greatly decrease the loss. The leaf-spot studies have also been brought to a close and a manuscript embodying the results completed. An investigation of alfalfa crown-wart has been begun, the field studies being conducted at Chico, Cal., where the disease is abundant. It is desired to ascertain whether this serious disease is likely to spread out of its present limitations and, if so, what measures can be taken to control it. Alfalfa yellows, as it occurs in the Middle Atlantic States, has also been studied. The work of breeding disease-resistant cowpeas has been continued to improve the strains further and keep them highly resistant.

*Cooperation.*—Wisconsin Experiment Station.

*Assignment.*—F. R. Jones, L. O. Watson.

*Proposed expenditures, 1918-19.*—\$3,800.

(See also Supplement—Emergency Activities, p. 555.)

**Total, Cotton, Truck, and Forage Crop Diseases, \$100,560, including \$12,760 statutory.**

[Research.]

## CROP PHYSIOLOGY AND BREEDING INVESTIGATIONS.

### Supervision:

*Object.*—This project covers the general office work necessary in connection with the scientific investigations.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Assignment.*—Walter T. Swingle.

*Proposed expenditures, 1918-19.*—\$8,620.

### Testing Farms on Indian Reservations:

*Object.*—To test crops likely to prove suitable for culture by the Indians while at the same time training the latter in methods of handling crops grown, with the help of Indian labor, by white settlers in regions near the reservations.

*Cooperation.*—Office of Indian Affairs, Department of the Interior.

*Location.*—Reservations at Sacaton, Ariz., Pyramid Lake, Nev., Shiprock, N. Mex., and Palm Springs, Cal.; to be extended later to other reservations in the Southwest.

*Results.*—Egyptian cotton, Peruvian alfalfa, Bermuda onions, and many other field and orchard crops have been introduced into culture, tried out under conditions prevailing on the reservations, and then made the basis of commercial culture by the Indians. The Egyptian cotton alone has brought an income of more than \$50,000 a year to the Indians since its satisfactory introduction some four years ago after several seasons of careful experimentation; while Bermuda onions, because of the important part they play in the diet, have proved an extremely valuable addition to the list of crop plants for cultivation by the Indians themselves on their reservations.

The work under this project, and in particular the investigations leading to the successful introduction of Egyptian-cotton culture, is described in Bureau of Plant Industry Bulletins 128, 156, 200, and 249, Department Bulletins 38, 311, and 332, Farmers' Bulletin 577, Journal of



Agricultural Research, vol. 2, No. 4, and various circulars and documents issued by the offices of the department cooperating in the work under the project. An office circular discussing the possibility of successful Bermuda-onion seed production in the southwestern United States has been prepared.

*Assignment.*—Walter T. Swingle, S. C. Mason.

*Proposed expenditures, 1918-19.*—\$5,130.

### **Date Culture and Breeding:**

*Object.*—To establish date culture on a successful commercial basis in those regions of the United States where soil and climatic conditions are favorable, and to develop, by breeding, new varieties better suited to American conditions than imported varieties.

*Procedure.*—A careful study was made of the soil, climatic, and cultural requirements of the date palm. Offshoots were then introduced from the Old World oases and planted in the regions which seemed best adapted to their culture, Government date gardens being established in these regions to permit a careful test of date culture before recommending it as a commercial proposition for American growers.

*Cooperation.*—University of Arizona at Tempe, Phoenix, and Yuma, Ariz., University of California at Mecca, Cal., and private growers in Arizona, California, and Texas.

*Location.*—Government Date Garden, Indio, Cal., and cooperative date gardens at Tempe and Yuma, Ariz., Mecca and El Centro, Cal., and Laredo, Tex.

*Date begun.*—Preliminary study as early as 1898; active work inaugurated in 1904.

*Results.*—Date culture has been established on a commercial basis in the southwestern United States, particularly in the Coachella Valley of California. Experiments are now being confined to working out the best methods for propagating offshoots, the artificial ripening of fruit in unfavorable seasons, and methods of packing which will permit of the wider utilization of inferior dates, now regarded as a more or less worthless by-product of the industry. Date-breeding experiments are also conducted, and many promising varieties have already been originated.

Date culture in general, with particular reference to the introduction and extension of the industry in America, is discussed in the Department Yearbook for 1900, Bureau of Plant Industry Bulletins 53, 54, and 92, Department Bulletins 223 and 271, Bureau Plant Industry Circular 129, and a number of informal circulars.

*Assignment.*—Walter T. Swingle, S. C. Mason; Bruce Drummond, foreman of the Government Date Garden at Indio, Cal.

*Proposed expenditures, 1918-19.*—\$15,130.

### **Caprification of the Fig and Breeding New Varieties of Figs and Caprifigs:**

*Object.*—To introduce Smyrna fig culture on a satisfactory basis in the United States.

*Procedure.*—A large assortment of the best caprifigs from the Old World has been introduced and the fig insect (*Blastophaga*), necessary for the proper fertilization of Smyrna figs, has been introduced and acclimatized. Breeding experiments are under way to originate new varieties of Smyrna figs and caprifigs especially suited to American conditions.

*Cooperation.*—Private growers in Arizona, California, and certain points in the Gulf States.

*Location.*—Government fig orchard at Loomis, Cal.; various cooperative experiments with private growers in Arizona, California, and the Gulf States.

*Date begun.*—Preliminary studies as early as 1898; active work inaugurated in 1904.

*Results.*—Smyrna fig culture has been put on a sound commercial basis in parts of California, where more than 6,000 tons of dried figs are now produced annually. Production is constantly increasing, with a tendency for the most part to grow only Smyrna figs.

During the past three years an attempt has been made to establish the fig insect (*Blastophaga*) in the Gulf States. During the past season this attempt was successful and experiments in caprifying figs, both of Smyrna and Adriatic types, are now in progress. While the commercial



production of Smyrna figs will probably always be restricted to regions, such as parts of California, having practically no rain during the ripening period, it now seems likely that fresh figs of the Smyrna type could be produced in some of the Gulf States and placed on the eastern markets in good condition if proper precautions were taken in packing for shipment.

*Assignment.*—Walter T. Swingle, G. P. Rixford, T. Ralph Robinson.

*Proposed expenditures, 1918-19.*—\$4,985.

### **Breeding of Citrus Fruits:**

*Object.*—To develop, by breeding, new hardy and disease-resistant types of citrus fruits.

*Procedure.*—All obtainable citrus species and their relatives are being secured and tested to determine their value as stocks or in breeding work. As rapidly as hybrids are secured they are tested out under field conditions to determine as quickly as possible their prospective commercial value.

*Cooperation.*—Agricultural experiment stations and private growers in the States mentioned under "Location."

*Location.*—Citrus-testing stations at Riverside, Cal., Glen St. Mary, Eustis, and Little River, Fla., and Loxley, Ala.; experiments with private growers in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Oregon, Texas, and Washington; special experiments also conducted in the greenhouses at Washington, D. C.

*Date begun.*—Preliminary work in 1897; active work inaugurated in 1907.

*Results.*—The experiments have so far resulted in the originating of the citranges, hardy substitutes for the lemon, which are proving useful as dooryard fruits in regions just outside the limits of ordinary lemon and orange culture; the tangelo, a grapefruit-tangerine cross, now becoming commercially important in Florida and a possible substitute for the grapefruit in Alabama and other points in the Gulf States, since it is apparently resistant to citrus canker, while the grapefruit is extremely susceptible; and the creation of a number of other citrus hybrids which show decided promise in their preliminary field tests.

A very important result of the investigations during the past year has been the recognition that the Satsuma oranges grown in the country are not of a single variety but actually represent several distinct strains, differing in important commercial characteristics and perhaps also in hardiness and canker resistance. This discovery has already been called to the attention of Satsuma growers in the Gulf States through lectures at the meetings of various societies in those States and by disseminating informal circulars describing the different strains of Satsuma now found in the United States and giving their relative commercial desirability as shown by years of growth in Japan. The existence of these different strains, unrecognized until recently in this country, has been responsible for a wide difference of opinion among consumers as to the value of the Satsuma.

The citrus-breeding work has been discussed in Bulletin 8 of the Division of Vegetable Pathology, Yearbooks of the Department for 1897, 1904, 1905, and 1906, Bureau of Plant Industry Circular 46, Journal of Agricultural Research, vol. 1, No. 1, vol. 1, No. 5, vol. 2, No. 2, and numerous papers contributed to Journal of the Washington Academy of Sciences, etc., or read at meetings of fruit growers. The new discoveries in regard to different strains of the Satsuma have been discussed in informal office circulars.

*Assignment.*—Walter T. Swingle, T. Ralph Robinson, E. Morris Savage.

*Proposed expenditures, 1918-19.*—\$19,940.

### **Dry-Land Arboriculture:**

*Object.*—To find deep-rooted and drought-resistant tree crops better suited to dry-land regions of the United States than the shallow-rooted annual crops now generally grown.

*Procedure.*—Laboratory and field tests are undertaken to determine the relative drought resistance and physiological requirements limiting the practical utilization of tree crops in dry-land regions.

*Cooperation.*—Private growers.

*Location.*—Sacaton, Ariz., Indio, Cal., Lampasas and San Antonio, Tex., Fallon and Pyramid Lake, Nev., and other points in Arizona, California, Texas, and Nevada.



*Date begun.*—1906.

*Results.*—A number of American species of *Prunus* have been discovered that are proving of value as stocks for commonly cultivated stone fruits in dry-land regions. A few of them have value in their present form, while others seem likely to prove valuable for breeding up new types of stone fruits.

Incidental tests are being made of special dry-land olives and an experimental tract on the cooperative testing station at Sacaton, Ariz., has been set aside for this purpose. Drought-resistant apricots, secured on a trip through the Dakhla oasis of Egypt, are being tested at several stations in the southwestern United States.

Dry-land olive culture and its future in the United States is discussed in Bureau of Plant Industry Bulletin 192, and the results of preliminary investigations on American species of *Prunus* are given in Journal of Agricultural Research, vol. 1, No. 2.

*Assignment.*—S. C. Mason.

*Proposed expenditures, 1918-19.*—\$3,815.

**(Establishment of Pistache Culture:** Discontinued as a separate project; included under "Miscellaneous."

#### **Miscellaneous:**

*Object.*—This project covers the minor work of the office—lines not yet sufficiently advanced to be handled as separate projects—its objects being (1) to introduce pistache culture on a satisfactory commercial basis; (2) to investigate the cause of increased yields in plants sprayed with Bordeaux mixture or other substances; (3) to modify and improve high-power microscopes in order to make them more readily available for the use of the investigator in scientific agriculture; and (4) to breed up new types of pineapples.

*Location.*—Laboratory work at Washington, D. C.; field experiments in California, Arizona, West Virginia, Florida, and the Gulf States.

*Date begun.*—Preliminary studies as early as 1898; general work begun in 1904.

*Results.*—Thousands of pistache stocks have been distributed to growers in California, Arizona, and Texas and a few in other States, which are being budded to the best commercial varieties. A new method of making Bordeaux mixture was discovered very early in these investigations and is now in practically universal use. New microscopic objectives have been originated, several improvements made in the mechanical stage, and an improved method worked out for the utilization of the naphthrobrom immersion objective. A few pineapple varieties have been originated which appear superior to any of the varieties now grown in this country.

A general description of the pistache nut and its culture is contained in an informal office circular. The improved method of making Bordeaux mixture is outlined in Journal of Mycology, vol. 7, No. 4 and Bulletin 9 of the Division of Vegetable Pathology. A phase of the work on improving the microscope is discussed in Science for August 9, 1907. Some of the new pineapple hybrids are described in Department of Agriculture Yearbooks for 1905 and 1906.

*Assignment.*—Walter T. Swingle, T. Ralph Robinson.

*Proposed expenditures, 1918-19.*—\$2,510.

**Total, Crop Physiology and Breeding Investigations, \$60,130, including \$11,670 statutory.**

[Research.]

### **SOIL-BACTERIOLOGY INVESTIGATIONS.**

#### **SUPERVISION.**

##### **Supervision:**

*Object.*—To carry on administrative, clerical, and routine laboratory work necessary for the proper conduct of the research projects.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—K. F. Kellerman.

*Proposed expenditures, 1918-19.*—\$12,300, including \$9,300 statutory.



## DISTRIBUTION AND STUDY OF LEGUME BACTERIA.

**Demonstration of Inoculation of Legumes:**

*Object.*—To demonstrate the benefit of inoculation of legumes with nitrogen-fixing bacteria by careful field experiments personally supervised.

*Procedure.*—Field experiments are carried on in cooperation with selected farmers in different regions of the United States, and the effect of different methods of preparing and distributing cultures, as well as different methods of inoculating and cultivating the legume crops, are tested on these farms.

*Cooperation.*—Selected farmers.

*Location.*—Georgia, Oklahoma, Pennsylvania, and Virginia.

*Date begun.*—1901.

*Results.*—Information is developed which leads to occasional improvement in methods for distributing cultures and for inoculating legumes.

*Assignment.*—K. F. Kellerman, F. L. Goll, L. T. Leonard.

*Proposed expenditures, 1918-19.*—\$3,430.

**Distribution of Cultures for Inoculating Legumes:**

*Object.*—To distribute pure cultures of nitrogen-fixing bacteria for general field tests in the inoculation of legumes, and to secure reports of results of inoculation from many farmers throughout the various regions of the United States, in order to have data for comparing the effectiveness of commercial cultures used in similar regions.

*Procedure.*—Upon request, liquid pure cultures of nitrogen-fixing bacteria are forwarded by mail to planters, who report on the success of the treatment after the crop is harvested.

*Location.*—Throughout the United States.

*Date begun.*—1901.

*Results.*—The pure-culture method has proved to be equal in efficiency to inoculation by the use of old field soil, and the quantity and quality of legume crops have been increased and improved throughout the United States.

*Assignment.*—K. F. Kellerman, L. T. Leonard.

*Proposed expenditures, 1918-19.*—\$3,720.

**Inspection of Commercial Cultures:**

*Object.*—To determine whether commercial cultures sold for inoculating legumes are impure, nonviable, or misbranded.

*Procedure.*—Commercial cultures are purchased in the open market and tested in the laboratory, in the greenhouse, and in the field.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—It is found that the quality of cultures now in the market is very satisfactory.

*Assignment.*—K. F. Kellerman, L. T. Leonard, F. L. Goll.

*Proposed expenditures, 1918-19.*—\$3,000.

**Laboratory Investigation of Legume Bacteria:**

*Object.*—To investigate the physiology and life history of strains of *Bacillus radicicola* and to determine the cross-inoculation of different legume bacteria.

*Procedure.*—Laboratory and greenhouse studies of methods for stimulating and maintaining the activity of legume bacteria are conducted, as well as studies to determine the varieties which are susceptible of infecting more than a single host.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—Improved methods for propagating and testing cultures have been developed and the character and proper name of the organism determined, and studies have been made on the intervarietal inoculation of soy beans and of the commonly accepted cross-inoculations of the alfalfa group, the clover group, and the garden-pea group, all of which have been verified in pure culture. Publication: "Influence of *Cerotoma Trifurcata* on the Nitrogen-Gathering Functions of the Cowpea." *Journal of the American Society of Agronomy*, vol. 10, No. 6.

*Assignment.*—K. F. Kellerman, L. T. Leonard.

*Proposed expenditures, 1918-19.*—\$1,270.

**Total, Distribution and Study of Legume Bacteria, \$11,420, including \$720 statutory.**



## INVESTIGATIONS IN SOIL BACTERIOLOGY.

**Investigations of the Organisms Causing Decomposition in Organic Material in Soils:**

*Object.*—To determine the causes of the different kinds of decomposition of organic matter and the conditions under which humus is produced in soils; to study the causes of the varying effects of green manures, barnyard manures, and crop residues in restoring, maintaining, and increasing the fertility of the soil, and to develop the rules for their most successful application.

*Procedure.*—Laboratory, greenhouse, and field studies of the biological conditions affecting plant growth upon various soils are conducted, as well as laboratory studies of the decomposition of the different organic manures. Greenhouse and field tests of the efficiency of these substances under different conditions are also carried out.

*Location.*—Washington, D. C.

*Date begun.*—1909.

*Results.*—It has been found that the formation of nitrate in different soils varies widely under the influence of the different green manures, barnyard manures, and crop residues. The nitrogen efficiency of these materials, tested in pot experiments, ranges, accordingly, between 0 and 80 per cent. In the field, mulching with green manures, first applied in the autumn of 1915, has already exerted a very favorable effect on the physical structure of the soil and on its life. These preliminary experiments have also furnished interesting details concerning the experimental error in laboratory, greenhouse, and field tests.

Publications: "A Method for the Determination of Nitric Nitrogen," *Journal of Biological Chemistry*, vol. 27, No. 1; "Further Experiments in the Destruction of Fly Larvæ in Horse Manure," *Department Bulletin* 245; "Some Filamentous Fungi Tested for Cellulose-Destroying Power," *Botanical Gazette*, vol. 60, No. 2; "The Determination of Reducing Sugars," *Journal of Biological Chemistry*, vol. 23, No. 1; "The Enzymes of *Aspergillus Terricola*," *Journal of Biological Chemistry*, vol. 19, No. 4; "A New Method of Precipitating Cellulose for Cellulose Agar," *Centralblatt für Bakteriologie*, Band 44, 1915, No. 17-23.

*Assignment.*—K. F. Kellerman, F. Löhnis, F. M. Scales.

*Proposed expenditures, 1918-19.*—\$8,840.

**Investigations of the Nitrifying, Denitrifying, and Nitrogen-Fixing Bacteria:**

*Object.*—To determine the relationships of the organisms which fix atmospheric nitrogen and those which cause nitrification and denitrification in soils, including a study of the morphology and physiology of *Bacillus azotobacter* and other important soil bacteria.

*Procedure.*—The work includes laboratory investigations at Washington, D. C., also laboratory and field studies at Riverside, Cal., in relation to citrus orchards, to determine the relationship between the available nitrogen in the soil and certain kinds of malnutrition of plants.

*Location.*—Washington, D. C., and Riverside, Cal.

*Date begun.*—1912.

*Results.*—It has been discovered that *B. azotobacter*, as well as all other bacteria, develops in regular life cycles, entirely unknown heretofore. This fact, when thoroughly studied, will become of considerable importance for soil biology as well as for all other branches of agricultural and medical bacteriology.

Symptoms of malnutrition of citrus trees developed both from an excessive supply of nitrate in the soil and from an insufficient supply of nitrate have been observed. Changes in methods of protecting the soil from evaporation and systems for applying water in irrigation ditches appear to offer means for correcting this difficulty.

Publications: "Life Cycles of the Bacteria," *Journal of Agricultural Research*, vol. 6, No. 18; "Fixation of Ammonia in Soils," *Journal of Agricultural Research*, vol. 9, No. 5; "Relation of the Transformation and Distribution of Soil Nitrogen to the Nutrition of Citrus Plants," *Journal of Agricultural Research*, vol. 9, No. 7.

*Assignment.*—K. F. Kellerman, F. Löhnis, F. M. Scales.

*Proposed expenditures, 1918-19.*—\$5,840.



**Study of the Relation of Soil Bacteria to Growth of Crop Plants:**

*Object.*—To determine the effect upon plants of products of bacterial growth.

*Procedure.*—Laboratory, greenhouse, and field studies are conducted to determine the influence of certain field crops upon the transformation of soil nitrogen.

Nonleguminous crops are grown under strictly control conditions on three classes of soil to determine the relative quantities of total nitrogen and nitrate nitrogen remaining in the soil after the removal of different crops, the relative quantities of nitrogen recovered in the crops, and the influence of the growth of these crops upon the ammonifying, nitrifying, and nitrogen-fixing powers of the soil. Work is also under way on the influence of the production of these crops upon the growth of succeeding crops in the same soil.

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—No conclusions of practical importance have yet been developed.

Publication: "Mutual Influence of Certain Crops in Relation to Nitrogen," *Journal of the American Society of Agronomy*, vol. 6, Nos. 4-5; "Growing Plants in Large Containers under Control Conditions," *Journal of the American Society of Agronomy*, vol. 8, No. 2; "The Action upon Soil Nitrogen of Certain Crops," *Science*, n. s., vol. 43, No. 1105.

*Assignment.*—K. F. Kellerman, F. Löhnis, F. M. Scales.

*Proposed expenditures, 1918-19.*—\$1,650.

**Total, Investigations in Soil Bacteriology, \$16,330, including \$1,680 statutory.**

**Total, Soil-Bacteriology Investigations, \$40,050, including \$11,700 statutory.**

[Research.]

**PLANT-NUTRITION INVESTIGATIONS.****General Investigations in Plant Nutrition:**

*Object.*—To study the growth, development, and composition of plants as affected by nutrition, more particularly the factors of nutrition controlling the quantity of oil produced in important oil-bearing seeds, the functions of the plant-food elements in nutrition, and the relative plant-food requirements of crops commonly grown in rotation.

*Procedure.*—Laboratory, greenhouse, and field investigations are conducted. In the work on the oil content of seeds experimental material is grown in the field and in the greenhouse under controlled conditions of temperature, light, moisture, and food supply, so as to determine the optimum conditions for oil-formation in the plant. In studying relative plant-food requirements the crop plants are grown on field plats so handled as to insure comparable conditions as to food requirements. In all cases the necessary laboratory study of the material is made.

*Cooperation.*—North Carolina and Maryland experiment stations.

*Location.*—Upper Marlboro, Md., Oxford, N. C., Arlington Farm, Va., and Washington, D. C.

*Date begun.*—1906.

*Results.*—It has been shown that the nutrition conditions of the plant play a leading part in oil production in seeds. The more general features of the work have been discussed in the *Journal of Agricultural Research*, vol. 3, No. 3. This paper gives information regarding the oil content of cotton seed, soy beans, and peanuts as affected by the plant-food supply and other soil and climatic conditions. More recently data have been obtained on the influence of light, temperature, and water supply on oil formation in the plant. The results to date indicate that temperature is the chief factor concerned. In studies on crop relationships, including the comparative plant-food requirements, as a basis for rational rotation of crops, some important results have been obtained. Striking effects of certain crop plants on the yields of succeeding crops have been obtained, and some unexpected differences have been observed in the effects of related crop plants on the crops following in rotation.

*Assignment.*—W. W. Garner, H. A. Allard, W. M. Lunn.

*Proposed expenditures, 1918-19.*—\$9,850.



**Nutrition of the Date Palm:**

*Object.*—To determine the optimum conditions for nutrition and fruit production of the date palm, and to develop therefrom a rational system of employing fertilizers in the different date-growing regions.

*Procedure.*—Laboratory experiments are conducted at Washington, D. C. Field experiments are carried on at Indio and Mecca, Cal., and Tempe, Ariz., for the purpose of examining orchard conditions and establishing rational fertilizer practices for the different regions.

*Location.*—Washington, D. C., Indio and Mecca, Cal., and Tempe, Ariz.

*Date begun.*—1912.

*Results.*—In the alkali soils which bake and thereby reduce the productivity of the date palm it has been found that the application of numerous small quantities of calcium sulphate improves the texture of the soil and also increases the yield and quality of the date and that an unbalanced or insufficient supply of food materials appears to injure the flavor of the cured dates. The most effective combination of fertilizer, as well as other food materials, has not yet been determined.

*Assignment.*—K. F. Kellerman.

*Proposed expenditures, 1918-19.*—\$1,100.

**Total, Plant-Nutrition Investigations, \$10,950.**

**[Research.]****SOIL-FERTILITY INVESTIGATIONS.****Supervision:**

*Object.*—To provide supervision, clerical assistance, and the miscellaneous administrative requirements for the proper conduct of investigations in soil fertility.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Assignment.*—Oswald Schreiner.

*Proposed expenditures, 1918-19.*—\$5,280.

**Maintenance of Soil Fertility:**

*Object.*—To study problems in the management and upbuilding of specific soil types, the best systems of rotation, and the effect of fertilizers. The work includes laboratory investigations on the composition of humus and soil organic matter generally.

*Procedure.*—Laboratory investigations and field observations are made. Prominent among these are field studies on the soil conditions and biochemical relationships in fields infected with diseases of the potato; study of potash hunger and similar fertility troubles of important food crops, including fertilizer treatments in overcoming potash hunger of the potato; fertilizer experiments in connection with the rust of cotton, with a view to determine the effect of various fertilizer ratios on this disease; fertilizer experiments in connection with pecan orchards, with a view to determine the effect of various fertilizer ratios on the growth and crop yield of pecan trees and also on the pecan rosette and other diseases; and fertilizer experiments to determine the effect of different rotations and soil treatments upon the maintenance of soil fertility.

*Cooperation.*—Bureau of Soils, Maine and Wyoming experiment stations, Virginia Truck Experiment Station, and individual farmers in Maine, Virginia, South Carolina, and Georgia.

*Location.*—Washington, D. C.; field studies in connection with diseases of the potato at Presque Isle, Aroostook Farm of the Maine Experiment Station, and other points in Maine; study of potash hunger at West Norfolk, Va.; effect of different rotations and soil treatments upon the maintenance of soil fertility at Sheridan, Wyo.; fertilizer experiments in connection with the rust of cotton at Florence, S. C.; fertilizer experiments in connection with pecan orchards at Putney and Cairo, Ga.

*Date begun.*—1904.

*Results.*—Organic fertilizers have been studied and the organic compounds composing the same determined, this investigation throwing much light on the availability of nitrogen. The relation between powdery scab of the potato and soil type or soil conditions has been determined. Information has been disseminated regarding specific soil



types and their management, the chemical nature of humus determined, and many substances isolated and identified and their distribution established. The nature of the disease known as potash hunger of the potato has been determined. The relation between soil conditions and potash hunger of the potato has been ascertained through soil and fertilizer studies, leading to a control of this trouble through soil adaptation to the fertilizer practice imposed by the limited potash supply.

*Assignment.*—Oswald Schreiner, B. E. Brown, J. J. Skinner, L. J. Gillespie, L. A. Hurst, R. B. Deemer, A. W. Francis.

*Proposed expenditures, 1918-19.*—\$7,896.

### **Causes of Unproductive Soils:**

*Object.*—To study organic substances causing infertility, such as result in the failure of specific crops, of orchards, die-back in citrus groves, clover-sick soils, etc.

*Procedure.*—Chemical laboratory investigations on soils from unproductive areas are conducted; field studies are also made.

*Cooperation.*—Florida and Indiana experiment stations; informal cooperation with individual farmers.

*Location.*—Washington, D. C., Scottsburg, Ind., and Gainesville, Fla.

*Date begun.*—1904.

*Results.*—Several additional organic compounds harmful to crop growth have been isolated from unproductive soils. Clover-sick soils are under investigation. Some of these compounds have been obtained from soils on which die-back of the orange occurs. A number of harmful substances have been isolated and identified and their occurrence determined.

*Assignment.*—Oswald Schreiner, J. J. Skinner, E. H. Walters, L. E. Wise, L. A. Hurst, A. W. Francis.

*Proposed expenditures, 1918-19.*—\$5,412.

### **Transformation and Formation of Soil Humus by Biochemical Factors:**

*Object.*—To study changes in soil organic matter and the formation of organic compounds by microorganisms and higher plants.

*Procedure.*—Biochemical laboratory investigations are conducted, including a study of the nature of compounds formed in the destruction of cellulose by soil organisms.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Results.*—The relation between soil acidity and hydrogen ion concentration established and a method of measurement perfected; behavior of organic fertilizers, like dried blood, in soils determined and the significance of protein hydrolysis and synthesis in relation to the availability of the nitrogen ascertained. It has been found that oxidation bears a fairly definite relation to soil fertility. Organic chemical compounds have been obtained from molds and soils identical in composition. The results secured have been applied to formation of humus.

*Assignment.*—Oswald Schreiner, L. J. Gillespie, R. N. Harger, A. W. Francis.

*Proposed expenditures, 1918-19.*—\$6,615.

### **Origin of Organic Constituents in Soils:**

*Object.*—To study the chemical transformation of organic matter in soils, which results in the formation of the constituents isolated from soils.

*Procedure.*—Biochemical laboratory investigations are made on the transformation of various organic materials in different soil types.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Results.*—The origin of several acids and aldehydes in soils has been determined. Organic matter added to soils has been found to break down along definite lines, yielding compounds some of which had previously been isolated from field soils.

*Assignment.*—Oswald Schreiner, R. N. Harger, A. W. Francis.

*Proposed expenditures, 1918-19.*—\$5,411.

### **Means for Improvement of Unproductive Soils:**

*Object.*—To determine the fertilizer and lime requirements of soils, the action of compounds isolated from soils, and the effect of fertilizers on these.



*Procedure.*—Greenhouse and nutrient-solution studies and field tests are made with certain fertilizers to study their action on the different organic soil compounds which have been shown to exist in soils. Soil aldehyde experiments are being conducted in cooperation with the Pennsylvania Experiment Station, and clover-soil investigations are carried on in connection with experiments in the growing of clover continuously on the same land.

*Cooperation.*—Pennsylvania and Wisconsin experiment stations.

*Location.*—Washington, D. C., Arlington Farm, Va., State College, Pa., and Ashland Junction, Wis.

*Date begun.*—1904.

*Results.*—The action of soil aldehydes on crops in the field and their elimination have been ascertained. Vanillin has been found to be counteracted by nitrate and salicylic aldehyde by phosphate fertilizer, resulting in improved crop yields. The effect of these aldehydes varies in degree with the soil, and it is shown that in some soils the aldehydes persist, whereas in others they disappear. Liming facilitates their disappearance. Information has been disseminated regarding specific soils, the properties of a considerable number of compounds ascertained, and the ameliorating action of specific fertilizers determined.

*Assignment.*—Oswald Schreiner, J. J. Skinner, F. R. Reid.

*Proposed expenditures, 1918-19.*—\$4,435.

### **Effect of Fertilizers and Soil Amendments:**

*Object.*—To study the various soil factors as influenced by fertilizers and soil amendments such as lime, manganese, etc., in the field and with different crops.

*Procedure.*—Plot and field work is carried on, including fertilizer ratio experiments in cooperation with the Pennsylvania Experiment Station and a study to determine the germination and yield differences in wheat grown in connection with fertilizer ratio experiments.

*Cooperation.*—Pennsylvania Experiment Station and Bureau of Chemistry.

*Location.*—Washington, D. C., Arlington Farm, Va., and State College, Pa.

*Date begun.*—1904.

*Results.*—The action of catalytic fertilizers like manganese is shown to be dependent on soil reaction. Manganese was ineffective for five years under acid-soil conditions. After correcting this acidity the manganese became very effective in producing an increase in crop yield and in soil oxidation. It has been shown that certain fertilizers, more than others, tend to produce soil acidity. Liming has been studied. It has been shown that not only are acid conditions remedied but oxidation is increased and harmful soil compounds destroyed.

*Assignment.*—Oswald Schreiner, J. J. Skinner, F. R. Reid, Henry Winckelmann.

*Proposed expenditures, 1918-19.*—\$5,091.

**Total, Soil-Fertility Investigations, \$40,140, including \$3,880 statutory.**

### **[Research.]**

## **CROP-ACCLIMATIZATION INVESTIGATIONS.**

### **SUPERVISION.**

#### **Supervision:**

*Object.*—To provide for clerical and administrative routine, laboratory experiments, and other general details connected with field investigations.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—O. F. Cook, G. N. Collins.

*Proposed expenditures, 1918-19.*—\$8,864, including \$4,500 statutory.

### **ACCLIMATIZATION, ADAPTATION, AND BREEDING OF COTTON.**

#### **Acclimatization of Weevil-Resistant Varieties:**

*Object.*—To secure varieties better suited to cultivation in weevil-infested regions and to acclimatize such varieties in the United States.

*Procedure.*—Weevil-infested regions in tropical America are visited to study the cultural conditions, habits, and special characters of the native varieties of cotton. Select stocks of the more promising foreign varieties



are brought to the United States for further selection and testing in various parts of the cotton belt in comparison with the varieties in regular cultivation. Much of the experimental work is done in cooperation with field stations conducted by the Offices of Western Irrigation Agriculture and Crop Physiology and Breeding Investigations of this bureau.

*Cooperation.*—Individual farmers.

*Location.*—Mexico, Central America, and the cotton belt of the United States.

*Date begun.*—1905.

*Results.*—Varieties with weevil-resistant characters have been discovered in Mexico and Central America and acclimatized in the United States. Superior strains have been bred from these imported stocks and are being established in cultivation in weevil-infested regions of the United States. Four of the newly acclimatized types—Durango, Acala, Kekchi, and Tuxtla—have yielded very promising varieties. In addition to special features that lessen the danger of weevil injury, the new varieties are very early and productive, with relatively larger bolls and longer lint than the types previously known to our planters. The Durango cotton is now being grown in commercial quantities in several districts, being preferred on account of the open habit of growth, strong central stalk, high yield, and excellent quality of lint. The Acala variety has been distributed and is becoming popular in northern Texas and Oklahoma, being earlier, more resistant to drought, and producing longer fiber than the varieties grown heretofore in that region. A new upland variety, called Meade, producing fiber of the length and quality of Sea Island cotton, but earlier and more productive under weevil conditions, is being introduced and acclimatized in Georgia, Florida, and South Carolina.

*Assignment.*—O. F. Cook, G. N. Collins.

*Proposed expenditures, 1918-19.*—\$6,117.

#### **Cotton Culture Under Weevil Conditions:**

*Object.*—To secure information concerning the local modifications of cultural methods necessitated by the presence of the boll weevil.

*Procedure.*—The structure and habits of growth of different kinds of cotton are studied under different conditions and with different methods of planting, thinning, and cultivation. The behavior of the plants is observed, and especially the extent to which their habits can be controlled by cultural methods. Much of the experimental work has been done in southern Texas at the San Antonio Experiment Farm, maintained by the Office of Western Irrigation Agriculture.

*Cooperation.*—Individual farmers, and Office of Extension Work in the South, States Relations Service.

*Location.*—That part of the cotton belt infested by the boll weevil.

*Date begun.*—1905.

*Results.*—An improved system of cotton culture has been developed which makes it possible to secure earlier and larger crops in short seasons and in the presence of the boll weevil. Experiments conducted in Virginia, North Carolina, South Carolina, Arkansas, Louisiana, Texas, Oklahoma, Arizona, and California show that the improved method is effective in promoting earliness, and increases of 20 to 100 per cent in the yield of seed cotton have been recorded. Detailed reports regarding these experiments have been published. The system is based on the discovery of two facts—that the cotton plant has two distinct kinds of branches and that the formation of the branches is controlled easily by cultural means. Suppression of the vegetative branches or secondary stalks of the plants insures a better development of the lower fruiting branches of the main stalk where the early crop is produced.

*Assignment.*—O. F. Cook, G. N. Collins.

*Proposed expenditures, 1918-19.*—\$7,233.

#### **Cotton Culture in Arid Regions:**

*Object.*—To ascertain the factors of cotton culture in arid regions and to determine the possibilities of extending cotton culture in portions of Texas and other Southwestern States where the boll weevil does not exist or is less destructive on account of the dry climate.

*Procedure.*—Varieties of cotton and cultural methods are tested in relation to drought resistance and other factors that affect their suitability



in dry climates, with or without irrigation. Much of the work is done at local stations conducted by the Offices of Western Irrigation Agriculture, Dry-Land Agriculture, and Crop Physiology and Breeding Investigations in Texas, Arizona, and California.

*Cooperation.*—Individual farmers.

*Location.*—Arizona, California, New Mexico, and Texas.

*Date begun.*—1906.

*Results.*—The extension of cotton growing into the more arid regions of the southwestern United States has been due very largely to the development of superior varieties and improved methods of culture. Durango cotton, acclimatized from Mexico, has shown distinct advantages over other long-staple Upland varieties in drought resistance as well as in adaptation to irrigation culture, and it is becoming one of the leading crops of this region, particularly in the Imperial Valley of California. The first observations and experiments that led to the discovery of the new single-stalk system of culture were made in connection with the Egyptian cotton and have contributed to the practical development of the Egyptian-cotton industry of the Salt River Valley of Arizona. As applied to the Egyptian cotton, the single-stalk system not only induces earlier fruiting and tends to insure larger crops but greatly facilitates the picking of the cotton at the end of the season, thus reducing the cost of production while increasing the yield. The success of cotton growing in the Imperial and Salt River Valleys has aroused a wider interest, and experiments have shown the possibility of growing cotton in many of the irrigated districts of Arizona and California. A bulletin has been published describing in particular the possibilities of cotton production in California, especially under conditions similar to those of the San Joaquin Valley.

*Assignment.*—O. F. Cook.

*Proposed expenditures, 1918-19.*—\$1,133.

#### **Local Adjustment and Adaptation of Cotton Varieties:**

*Object.*—To ascertain the nature and importance of special characters or differences that determine the agricultural values of varieties of cotton and their suitability to cultivation under particular local conditions.

*Procedure.*—The same series of varieties is planted under different conditions in the several sections of the cotton belt, and changes of behavior, as well as differences between stocks of the same variety grown in the same place, are observed, the product of locally grown seed being compared with that of seed raised in other places.

*Cooperation.*—Individual farmers.

*Location.*—Cotton belt of the United States.

*Date begun.*—1909.

*Results.*—Experiments in many localities indicate a general superiority of varieties that have been bred in Texas from Mexican or Central American stocks over the type represented by most of the short-staple varieties grown in the Southeastern States. Experiments have shown that locally grown and selected seed usually gives better results than seed of the same variety brought in from some other region where the conditions of growth are different. Selection for local adjustment is shown to be necessary before the full possibilities of a variety in a given district can be determined. Varieties tested on a basis of local adjustment prove to be adapted to a wide range of natural conditions, thus making possible a more extensive utilization of superior varieties and showing that the present multiplicity of varieties is unnecessary as well as undesirable. The Durango variety is grown successfully in Virginia and other Southeastern States as well as in the Imperial Valley of California. The Meade variety, originated in the Red River Valley of Texas, is being grown and selected for local adjustment to the conditions of the Sea Island districts of the South Atlantic States and also in the San Joaquin Valley of California. Study of local-adjustment problems has also led to a recognition of the advantages to be gained by the organization of cotton-growing communities for the exclusive production of a single superior variety so that stocks may be kept pure and uniform, thus increasing production and giving both seed and lint a higher market value.

*Assignment.*—O. F. Cook, G. S. Meloy.

*Proposed expenditures, 1918-19.*—\$2,267.



**Breeding and Preservation of Cotton Varieties:**

*Object.*—To improve varieties of cotton by selection of the best strains and to develop improved methods of selection in order that adequate supplies of pure seed of superior varieties may be maintained.

*Procedure.*—Detailed tests and comparisons of varieties are made to learn the characters and habits which are of the most importance from the standpoint of production. Methods of breeding and selection are studied from the standpoint of practicability of application and efficiency in maintaining the uniformity of the stocks.

*Cooperation.*—Individual farmers.

*Location.*—Cotton belt of the United States.

*Date begun.*—1909.

*Results.*—Varieties of cotton have been developed that are superior to those in general cultivation, not only in yield and earliness but in the length, quality, and uniformity of the staple. These varieties are being established in cultivation and supplies of pure seed are being maintained by improved methods of selection. Study of the plant characters of the different varieties has made it possible to recognize and remove hybrids or aberrant individuals from the fields, thus protecting select stocks from contamination and deterioration through loss of uniformity. Five varieties are now being sent out through the congressional seed distribution, four of which have attained prominence. The Lone Star variety, representing the Texas big-boll type of cotton, is becoming recognized as one of the leading varieties in Texas, Oklahoma, and adjacent States. It is now being introduced in Louisiana, Mississippi, Alabama, and Georgia with the advance of the boll weevil and is being received very favorably. Acala, another of the varieties acclimatized from Mexico, has been found earlier than Lone Star or other big-boll cottons in Oklahoma and northern Texas and is being planted extensively. The Trice variety, an extra-early sort bred from a local stock in western Tennessee, has given excellent results across the northern rim of the cotton belt and in weevil-infested regions where a very short-season variety is needed. The Columbia variety, also known as Webber, has been grown extensively in South Carolina and adjacent States, but now seems likely to give place to the Durango cotton, which matures in a shorter season. The Meade variety of Upland cotton is being substituted for Sea Island in Georgia. The methods of distributing the seed, under the established congressional system, have also been improved so as to assist in establishing superior varieties in regular cultivation in communities that can serve as centers of production of pure seed and thus make possible a wider utilization of the varieties. This is accomplished by following the general distribution of small trial packages, with a special distribution of larger quantities of seed in communities that show the best prospect of using a variety extensively and producing supplies of good seed.

*Assignment.*—O. F. Cook, D. A. Saunders, G. S. Meloy, C. B. Doyle.

*Proposed expenditures, 1918-19.*—\$11,216.

**Maintenance of improved Varieties of Cotton in Texas and Adjacent States:**

*Object.*—To extend the utilization of improved varieties of cotton by providing for the establishment and maintenance of commercial supplies of planting seed of the improved varieties, and to cooperate with the various governmental and commercial agencies having contacts with the cotton industry with a view to discover and demonstrate the best methods of increasing the efficiency of cotton production.

*Procedure.*—It is proposed to extend the application of the work now carried on under the project "Breeding and Preservation of Cotton Varieties" through the employment of additional men to conduct breeding work on a cooperative basis at several field stations in the cotton belt, and to inspect and rogue increase fields of the improved varieties that may be planted by farmers in organized communities, especially in the vicinity of these field stations; to establish a cotton-breeding field station at Greenville, Tex., similar in size and in plan of operation to the field stations now operated by this bureau at San Antonio and Big Springs, Tex., and at Lawton, Okla.; to enlist the cooperation of county agents and district leaders of the Office of Extension Work in the Southern States in the selection of farmers as cooperators in the



production of supplies of seed of the improved varieties of cotton resulting from the breeding and testing work on these field stations, and to assist in the organization of these farmers into cooperative seed-growing associations through which the seed of these improved varieties may be sold to cotton farmers generally; to enlist the cooperation of the Bureau of Markets in organizing cooperative cotton-growing communities and in having the lint from improved varieties of cotton classed and graded in comparison with the stocks now being grown in these communities, so that the advantages of organized production of superior varieties may be demonstrated in the most practical way.

*Cooperation.*—Office of Extension Work in the Southern States and the Bureau of Markets; also farmers' organizations in the vicinity of the field stations.

*Location.*—Headquarters, Washington, D. C.; seed-breeding station at Greenville, Tex., with substations or cooperative experimental work at San Antonio, Big Springs, and Clarksville, Tex., and Lawton, Okla.

*Date begun.*—1917.

*Results.*—In cooperation with local communities at Greenville and other points in Texas and Oklahoma, larger supplies of pure seed are being established and maintained and larger commercial quantities of superior, uniform fiber are being produced and sold at distinct premiums above the price of cotton raised from ordinary stocks. In Hunt County, where the Greenville station is located, the advantage to the farmers in the season of 1917 has been estimated at \$700,000.

*Assignment.*—O. F. Cook, D. A. Saunders.

*Proposed expenditures, 1918-19.*—\$29,500.

**Total, Acclimatization, Adaptation, and Breeding of Cotton, \$57,466.**

#### ACCLIMATIZATION, ADAPTATION, AND EXTENSION OF CORN.

##### Acclimatization, Adaptation, and Extension of Corn:

*Object.*—To secure varieties of corn adapted to special conditions outside of the principal corn-growing States, particularly in the subtropical Gulf region, the arid Southwest, and the Pacific-coast States.

*Procedure.*—The behavior of the different types and varieties of corn in experimental plantings in the United States and in foreign countries is compared and studied, in order to ascertain the special characters or habits of growth that render the varieties adapted to particular conditions or uses and to ascertain the best methods of utilizing adaptive characters in developing superior varieties by selection or hybridization.

*Cooperation.*—State experiment stations, and individual farmers.

*Location.*—Central and South America, Mexico, and tropical, subtropical, and arid regions of the United States.

*Date begun.*—1905.

*Results.*—Outside of the United States corn has been found growing and producing satisfactory yields under a much wider range of climatic and soil conditions than our varieties would permit. Studies of a number of these foreign varieties have shown that they possess adaptations that especially fit them to withstand the extreme conditions under which they have been produced. Through the introduction and hybridization of these varieties it has been possible to develop strains having resistance to low temperatures, drought, high winds, and attacks of insects. It has been demonstrated that with the effects of selection eliminated transfers of seed from one locality to another is beneficial rather than otherwise. Through hybridization with southern varieties of field corn, a strain of sweet corn has been developed that is partially immune to the attacks of the corn worm. Seed is now being grown for commercial distribution. A method has been developed by which it is possible to harvest ears of sweet corn at the proper stage for eating, avoiding the loss through harvesting immature and over-ripe ears. By hybridizing corn with related grasses, *Euchlaena* and *Tripsacum*, plants of many intermediate forms have been produced, some of which give promise of value as forage crops.

*Assignment.*—G. N. Collins, J. H. Kempton.

*Proposed expenditures, 1918-19.*—\$6,600.



## ACCLIMATIZATION AND ADAPTATION OF TROPICAL PLANTS.

**Acclimatization and Adaptation of Tropical Plants:**

*Object.*—To determine the possibilities of acclimatizing and establishing in the United States superior varieties of crop plants that are natives of tropical countries.

*Procedure.*—Investigations are begun in foreign countries in order to learn the native conditions, habits, special characters, cultural requirements, and uses and to select the best strains for acclimatization, breeding, and testing in the United States. Explorations and experiments are conducted in cooperation with the Offices of Foreign Seed and Plant Introduction, Western Irrigation Agriculture, and Crop Physiology and Breeding Investigations of this bureau.

*Cooperation.*—Private growers, nursery firms, and park authorities in the Southern and Southwestern States.

*Location.*—Foreign countries, Washington, D. C., Southern and Southwestern States, and the tropical and subtropical possessions of the United States.

*Date begun.*—1909.

*Results.*—The varieties of many tropical crop plants have been studied in tropical regions and tablelands of Central and South America and seeds or propagating materials secured, including cotton, corn, potatoes, cassava, and other root crops, vegetables and fruits, such as coffee, cacao, bananas, and avocados, and economic palms. A new type of hardy hard-shelled avocados better adapted to commercial production than the varieties previously known was discovered in Guatemala. Many of the imported stocks that behave abnormally and are unproductive when first planted in the United States showed gradual improvement in subsequent seasons and eventually produce useful varieties. Some of these are likely to be of use on the Pacific coast and other districts with cool climates and others in tropical districts of southern California and Florida. The discovery of special adaptive characters of cotton and corn are among the results of these tropical investigations, and other tropical crops are being studied chiefly in connection with expeditions and experimental work with cotton and corn varieties. General information on tropical economic plants and vegetable products is furnished. Several millions of dollars undoubtedly have been saved to the American public by publishing the results of the bureau's investigations of rubber culture, which served as an effective warning against bad investments in planting enterprises which have since proved to be worthless. Studies of coffee, cacao, and bananas have resulted in the discovery of new cultural improvements of importance to growers of these crops.

*Assignment.*—O. F. Cook, C. B. Doyle.

*Proposed expenditures, 1918-19.*—\$3,650.

**Total, Crop-Acclimatization Investigations, \$76,580, including \$4,500 statutory.**

[Research.]

**FIBER-PLANT INVESTIGATIONS.****Sisal, Henequén, and Allied Plants:**

*Object.*—Increased production of fiber suitable for binder twine.

*Procedure.*—Information about fiber-producing agaves and furcraeas is secured, and, if promising, efforts are made to obtain plants and try them in Porto Rico and Hawaii. Improved strains of sisal and henequén are being developed by selection in cooperation with the experiment station at Mayaguez, P. R. Information is obtained by means of personal investigation, correspondence, and publications regarding soils, climate, methods of cultivation, diseases, fiber-cleaning machines, and economic conditions under which these plants are cultivated profitably. The information thus acquired is used to encourage the establishment of plantations where conditions are favorable and to warn would-be investors against wasting money on unprofitable plants or in trying to grow plants under impossible conditions.

*Cooperation.*—Porto Rico Experiment Station.

*Location.*—Washington, D. C., Mayaguez, P. R., Sisal and Robinson, Hawaii, and Haiti.

*Date begun.*—1902.



*Results.*—Numerous introductions of plants have been made into Porto Rico and Hawaii and trials conducted of several species in southern Texas and southern Florida, all indicating that sisal and henequén are the most promising species, with the possible exception of zapupe verde in southern Texas. Many different species have been identified and information about them secured.

*Assignment.*—Lyster H. Dewey, Harry T. Edwards.

*Proposed expenditures, 1918-19.*—\$8,275.

### **Production of Binder-Twine Fibers in the Philippines:**

*Object.*—To increase the supply of fiber suitable for binder twine and to give profitable employment to labor in the Philippines, developing a crop on lands not now used or adapted to other profitable uses.

*Procedure.*—Personal direction and advice are given in planting, cultivating, and preparing the fiber; fiber-cleaning machines are introduced; improved varieties of plants are introduced.

*Cooperation.*—Philippine Bureau of Agriculture.

*Location.*—Washington, D. C., and Manila, Cebu, Ilocos Sur, and Ilocos Norte, P. I.

*Date begun.*—1917.

*Results.*—Two fiber-cleaning machines are in operation in the Philippines, demonstrating that sisal fiber can be cleaned at less cost and a better quality produced than that obtained by hand methods used heretofore. The planters at San Fernando, in Cebu, are so impressed with the demonstration that they are ordering more cleaning machines and increasing their plantings. It has been demonstrated further that sisal is superior in nearly all respects to Manila maguey, which has been grown more extensively heretofore, and the planters are changing from maguey to sisal as fast as propagating stock can be secured. This office has sent 500,000 young plants to the Philippines.

*Assignment.*—Lyster H. Dewey, Harry T. Edwards.

*Proposed expenditure, 1918-19.*—\$15,500.

### **Flax Fiber Production:**

*Object.*—To encourage the production of flax fiber in regions in this country adapted to the crop in order to meet the increasing demand for this fiber and to prevent waste of capital in impractical schemes; also to develop in the United States the production of seed of improved fiber types of flax.

*Procedure.*—Information is furnished by means of letters, personal consultation, and bulletins to flax growers. Improved types of fiber flax are being developed by plant breeding. Increase plats of improved strains are now being grown in Michigan. Time is gained by growing increase plats in Porto Rico in winter.

*Cooperation.*—Michigan Agricultural College.

*Location.*—Washington, D. C., East Lansing, Mich., and Porto Rico.

*Date begun.*—1902.

*Results.*—Definite knowledge has been obtained that fiber types of flax are distinctly different from types commonly grown for seed, and attention has been called to the futility of attempting to produce spinning fiber from ordinary seed flax. Improved strains of fiber flax have been developed, and the seed is now being increased. It has been demonstrated that, contrary to the generally accepted theory, fiber flaxseed may be produced in this country fully equal to that imported.

*Assignment.*—Lyster H. Dewey, Robert L. Davis.

*Proposed expenditures, 1918-19.*—\$3,500.

### **Hemp Fiber Production:**

*Object.*—To encourage the production of hemp fiber in the United States in regions where hemp promises as good profits as other crops; to develop supplies of American-grown fiber for American spinning mills.

*Procedure.*—Improved types of hemp are developed by plant breeding. Seed of these improved types is distributed to commercial hemp-seed growers. Information as to the best methods of handling the crop is secured and disseminated. Information about uses of the fiber, qualities desired for particular purposes, supplies, and markets is given by letters and other means to aid the growers.

*Cooperation.*—Wisconsin, Michigan, Kentucky, and Missouri experiment stations, and many hemp-seed growers in Kentucky.



*Location.*—Washington, D. C., Madison, Wis., East Lansing, Mich., Lexington, Ky., and Columbia, Mo.

*Date begun.*—1902.

*Results.*—Hemp-fiber production has increased from about 1,500 tons in 1914 to more than 15,000 tons in 1917. Most of this hemp is grown from seed of improved varieties developed by this office. Present supplies are sufficient in quantity to meet the increasing demands of American mills, and the increased production permits hems to become an important emergency fiber for binder twine.

*Assignment.*—Lyster H. Dewey, A. H. Wright.

*Proposed expenditures, 1918-19.*—\$4,000.

**(Ramie Fiber Production:** Project held in abeyance until methods for preparing the fiber have been developed so as to give promise of success. Time is required for answering numerous letters about ramie.)

**(Improved Teazel Production:** This project has been discontinued, as there appears to be little hope of securing results of practical value by any method to be carried out by this department. Imported seed failed to germinate. Teazels of different types, some of them practically the same as those imported, are now cultivated in New York and Oregon. The quantity produced varies with the demand, and any marked increase in production would result in oversupply.)

#### **Phormium (New Zealand Flax) Fiber Investigations:**

*Object.*—To determine whether phormium can be cultivated successfully and profitably for fiber production in the United States, especially to produce additional supplies of fiber for binder twine.

*Procedure.*—Propagating stock of phormium plants will be secured and planted where conditions are regarded as most favorable. Machinery for cleaning phormium fiber will be secured, if possible, and trials made in the production of fiber from plants now growing in California and the Gulf States.

*Location.*—Bard or El Centro, Cal.; Gainesville or Miami, Fla.

*Date begun.*—July 1, 1918.

*Assignment.*—Lyster H. Dewey.

*Proposed expenditures, 1918-19.*—\$3,500.

#### **Miscellaneous Fiber Investigations:**

*Object.*—To collect, record, and disseminate information about all kinds of plant fibers, except cotton, used for textiles, brushes, stuffing, and coarse weaving; to identify fiber plants and plant fibers; to conduct experiments in cultivating some of the more promising fiber plants.

*Procedure.*—Information is secured from literature, periodicals, correspondence, and personal observation and filed for ready reference. Some of the more promising plants are grown at the Arlington (Virginia) and Yarrow (Maryland) farms and some tropical ones in Porto Rico.

*Location.*—Washington, D. C.

*Date begun.*—1890.

*Results.*—More than 3,000 inquiries about fiber plants of minor importance are answered each year.

*Assignment.*—Lyster H. Dewey.

*Proposed expenditures, 1918-19.*—\$3,830.

**Total, Fiber-Plant Investigations, \$38,605, including \$3,175 statutory.**

[Research.]

### **DRUG-PLANT, POISONOUS-PLANT, PHYSIOLOGICAL, AND FERMENTATION INVESTIGATIONS.**

#### **SUPERVISION.**

##### **Supervision:**

*Object.*—To provide supervision, clerical assistance, and the miscellaneous administrative needs of the projects of this group.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Assignment.*—R. H. True, W. W. Stockberger.

*Proposed expenditures, 1918-19.*—\$13,649, including \$9,860 statutory.



**DRUG AND RELATED PLANTS AND THEIR PRODUCTS.****Oil-Seed Crop Production:**

*Object.*—To obtain information regarding the oil-seed crop possibilities of various sections of the United States and determine what oil seeds may be successfully grown and profitably utilized; to secure data on the best cultural methods, including crop rotation, the use of fertilizers, methods of harvesting and thrashing, etc.; to increase the agricultural resources of the United States by developing new sources of fatty oils, and to extend the use of oil-seed products by manufacturers using these or similar products.

*Procedure.*—Row and plat tests are made in the case of new crops, followed by field tests of promising crops. Cultural requirements are determined from experimental plantings and the best methods of treatment tested on a field basis, in cooperation with practical farmers. Commercial tests of various oil seeds are made, in cooperation with manufacturers of vegetable oils.

*Cooperation.*—Individual farmers and manufacturers.

*Location.*—South Carolina and points in various other States.

*Date begun.*—1916 as a separate project; work along this line carried on since 1908 under the project "Miscellaneous Field and Laboratory Work on Drug and Related Plants."

*Results.*—Trial cultures have been made with a number of oil-seed crops produced abroad but new to the United States, and information has been obtained on the possibilities of profit in extending the production of oil-seed crops in this country. Plantings on an acreage basis sufficiently large to afford practical commercial tests of several of these crops are in progress, and through cooperation with manufacturers information is being obtained on the value of the oils concerned for use in the manufacture of paints, varnishes, and other products. Sunflower seed grown in these experiments yielded 21 per cent of fixed oil, which is not only edible and suitable for culinary purposes but also promises to be of value in the manufacture of varnish and other industrial uses.

*Assignment.*—W. W. Stockberger, J. H. Shrader, Thomas B. Young.

*Proposed expenditures, 1918-19.*—\$3,865.

**Essential-Oil Crop Production:**

*Object.*—To introduce essential-oil crops into commercial culture in the United States, develop improved types of essential-oil plants, and work out economical methods of harvesting these crops and preparing the oils therefrom.

*Procedure.*—Studies are made of the culture of various plants yielding volatile oils, including their propagation, planting, tillage, and fertilization. Individual plants of the most desirable types are selected and propagated. Methods of harvesting the plants and distilling the oils are studied and the machinery and apparatus needed in these operations devised or improved when necessary. The oils or the marketable products therefrom are tested, in cooperation with the manufacturers using these or similar products. Data on the commercial production of essential-oil crops are obtained from field trials and from cooperators' records of the sales of products.

*Cooperation.*—Orange County (Fla.) Fair Association and individual growers.

*Location.*—Arlington Farm, Va., Orlando, Fla., and points in other States.

*Date begun.*—1916 as a separate project; work in progress along this line since 1908 under the project "Miscellaneous Field and Laboratory Work on Drug and Related Plants."

*Results.*—Data in Department Bulletins—372, "Commercial Production of Thymol from Horsemint"; 399, "The Production of Sweet-Orange Oil and a New Machine for Peeling Citrus Fruits"; and 442, "Possibility of the Commercial Production of Lemon Grass Oil in the United States." Field tests are in progress with *Mentha citrata* and rose geranium; also experiments with perfume roses with a view to test their possibilities for commercial production in the United States.

*Assignment.*—W. W. Stockberger, G. A. Russell.

*Proposed expenditures, 1918-19.*—\$1,885.



**Vegetable-Oil Investigations:**

*Object.*—Study of the fixed and volatile oils yielded by wild and cultivated American plants, with reference to their technical value.

*Procedure.*—Wild aromatic plants are investigated as possible new sources of volatile oils. Such oils when obtained are analyzed to determine their possible commercial value in the perfumery, flavoring-extract, and soap-making industries. The fixed and volatile oils from plants now cultivated on a commercial scale are subjected to laboratory tests to determine their quality and quantity and the technical value of their constituents. Study is also made of the effects of cultivation, time of harvest, and climatic and soil conditions on the yield and quality of these oils. Investigations on linseed oil are conducted in cooperation with the Office of Cereal Investigations of this bureau.

*Location.*—Washington, D. C.; crop facilities furnished by the various testing gardens of this office, located at Arlington Farm, Va., Madison, Wis., Orlando, Fla., and Ebenezer, S. C.

*Date begun.*—1906.

*Results.*—Increasing shortage of fats and oils has emphasized the importance of encouraging the production of vegetable oils and their more general use as food and in the industries dependent upon these products. Preliminary work carried out with oils of sunflower, sesame, poppy, castor bean, perilla, lallemantia, and other oil-seed crops indicates the possibility of an enormous increase in the annual output of vegetable oils. Laboratory studies of oil from samples of flaxseed grown under diverse conditions of soil and climate, conducted in cooperation with the Office of Cereal Investigations, have yielded data which it is believed will make possible the adjustment of flax varieties to the conditions under which the maximum yield of oil of high quality can be obtained. The possible oil supplies available through the utilization of oil-yielding wastes such as the seeds of the tomato, cherry, prune, peach, grape, and other similar by-products have been demonstrated. Publications include Bureau of Plant Industry Bulletins—195, "The Production of Volatile Oils and Perfumery Plants in the United States," and 235, "Wild Volatile Oil Plants and Their Economic Importance"; Journal of Agricultural Research, vol. 2, No. 2, "The Aroma of Hops with Special Reference to the Effect of Geographic Source upon the Yield of Hops"; Department Bulletins—454, "The Effect of Cultural and Climatic Conditions upon the Yield and Quality of Peppermint Oil"; 632, "Utilization of Waste Tomato Seeds and Skins"; and 655, "Influence on Linseed Oil of the Geographic Source and Variety of Flax"; and various articles on vegetable-oil products published in technical journals outside the department.

*Assignment.*—J. H. Shrader, Frank Rabak.

*Proposed expenditures, 1918-19.*—\$4,105.

(See also Supplement—Emergency Activities, p. 557.)

**Investigations of the Active Constituents of Medicinal Plants:**

*Object.*—To ascertain the influence of climate and cultural conditions on the active constituents of medicinal plants; to determine the individual variation in the alkaloidal content of medicinal plants as a basis for improvement by selection; and to obtain data regarding the effect of time of collection and mode of preparation on the activity of plant drugs.

*Procedure.*—Individual plants grown under different conditions are analyzed and the alkaloidal content or degree of toxicity noted. Individual plants having a common parentage are grown under similar conditions and analyzed, the results giving a basis for selection of desirable types for further propagation. Various medicinal roots, leaves, etc., collected at different seasons and in varying stages of growth, are analyzed to determine the procedure which gives the best quality of drug.

*Location.*—Washington, D. C.

*Date begun.*—1916 as a separate project; work developed in connection with other projects since 1912.

*Results.*—A new strain of belladonna has been developed which has a greatly increased alkaloidal content and points the way to a very great improvement in the quality of this drug as usually found on the market. Data published in Journal of Agricultural Research, vol. 1, No. 2, "Individual Variation in the Alkaloidal Content of Belladonna Plants"; Department Bulletin 306, "Some Effects of Selection on the Production of



Alkaloids in Belladonna"; also "Notes on the Rubber from *Eucommia ulmoides*" and articles on the germination of belladonna, etc., published in technical journals.

*Assignment.*—A. F. Sievers.

*Proposed expenditures, 1918-19.*—\$2,290.

### **Breeding of Medicinal Plants:**

*Object.*—To secure improved strains of medicinal plants by breeding.

*Procedure.*—An attempt is being made to develop new and advantageous forms of the various plants used in medicine. Individual plants are sought possessing in the highest degree the desired qualities as a foundation for strains or varieties of greater economic value than we now possess. After desirable characters have been well developed under proper selective methods, accompanied by specially favorable cultural conditions, crossing is resorted to for combining diverse characteristics and increasing variation.

*Location.*—Washington, D. C., Arlington Farm, Va., and Glenn Dale, Md.

*Date begun.*—1916.

*Results.*—About 170 species of drug and related plants are under experimental culture on the heavy clay at Arlington Farm, Va., and on sandy loam near Glenn Dale, Md. Research on the improvement of plant drugs and on conditions most favorable to their production in various parts of this country has been further extended through cooperation in the establishment of drug gardens in connection with the schools of pharmacy of a number of educational institutions.

*Assignment.*—W. W. Stockberger.

*Proposed expenditures, 1918-19.*—\$790.

### **Commercial Production of Drug and Related Plants in the Upper Mississippi Valley:**

*Object.*—To determine, first by small experimental cultures and then by actual crop tests in the field, what drug and related plants can be grown successfully in the upper Mississippi Valley, and to investigate methods of handling these crops and of preparing the products for market.

*Procedure.*—Plants believed to be adapted to the region in question are grown in small experimental plats and the details of their cultural requirements worked out. Those which appear promising are then tested under the actual conditions of crop production, usually in cooperation with practical farmers. The cost of production and marketing and the return from sales are recorded for each crop.

*Cooperation.*—University of Wisconsin.

*Location.*—Madison, Wis.

*Date begun.*—1916 as a separate project; work has been in progress along this line since 1908 under the project "Miscellaneous Field and Laboratory Work on Drug and Related Plants."

*Results.*—Definite data secured regarding the cultural requirements of more than a hundred drug and related plants; information disseminated on commercial possibilities for these plants. The work has included commercial tests under actual farm conditions with several of the more important drug crops. Special attention has been given to the commercial production of sage.

*Assignment.*—W. W. Stockberger, N. R. Mueller.

*Proposed expenditures, 1918-19.*—\$420.

### **Commercial Production of Drug and Related Plants in the Northwestern United States:**

*Object.*—To determine, by small experimental cultures, supplemented by field tests on an acreage basis, what drug and related plants can be grown successfully in the Northwest; and to investigate methods of handling these crops and of preparing the products for market.

*Procedure.*—Having ascertained the cultural requirements of plants believed to be adapted to the Northwest, those which appear promising are tested under conditions of crop production on a practical commercial scale.

*Cooperation.*—University of Washington (College of Pharmacy).

*Location.*—Seattle, Wash.

*Date begun.*—1918 as a separate project; work has been in progress along this line since 1917 under the project "Miscellaneous Field and Laboratory Work on Drug and Related Plants."



*Results.*—Through cooperation with the University of Washington, facilities have been secured which will make it possible to obtain first-hand information concerning the actual adaptability of a number of drug and related crops to the Pacific Northwest, also concerning the utilization of certain important wild drug plants, such as digitalis and henbane, which are found in this region.

*Assignment.*—W. W. Stockberger, James Thompson.

*Proposed expenditures, 1918-19.*—\$1,420.

### **Investigations of Plant Waste Products as Commercial Sources of Fixed Oils, Volatile Oils, and Other Valuable Constituents:**

*Object.*—To determine the commercial value of wastes resulting from canning, packing, or other methods of preparing plant products.

*Procedure.*—Sources of wastes resulting from various canning and packing operations are determined and information secured regarding the annual output and disposal of various waste products. Samples are taken of the wastes occurring in promising quantities for investigation in the laboratory, where the various important constituents are extracted and methods devised for their preparation in useful form.

*Cooperation.*—Canners, packers, and various manufacturers.

*Location.*—Washington, D. C.

*Date begun.*—1916 as a separate project; previously the work on waste products has been done under the project "Vegetable-Oil Investigations."

*Results.*—A study of certain by-products of the fruit and canning industry has shown important sources of value in waste products heretofore unutilized. The more important results obtained to date may be found in Bureau of Plant Industry Bulletins 133, "Peach, Apricot, and Prune Kernels as By-Products of the Fruit Industry of the United States," and 276, "Utilization of Waste Raisin Seeds," and Department Bulletin 350, "Utilization of Cherry By-Products." Waste tomato seeds which accumulate in large quantities in factories where soups and ketchups are prepared have been investigated as a source of fixed oil, and a report on the commercial utilization of this material is in course of preparation. Studies of waste almond skins and of waste raspberry seeds resulting from the manufacture of raspberry flavor and sirup, have been completed, and a report on the fixed oils derived from these wastes is being prepared for publication.

*Assignment.*—Frank Rabak.

*Proposed expenditures 1918-19.*—\$1,865.

### **Utilization of Drug and Related Crop Wastes:**

*Object.*—To determine the value and possible utility of drug and related crop wastes.

*Procedure.*—The spent plant material resulting when volatile-oil crops are distilled is tested for value as stock feeds or fertilizers. Useful constituents are sought in the crop by-products resulting from the preparation of crude plant drugs. Studies are made of the best methods of utilizing waste stalks, leaves, hulls, or other plant parts rejected in working up various drug and related crops.

*Location.*—Washington, D. C., and Orlando, Fla.

*Date begun.*—1915.

*Results.*—Spent herb of horsemint (*Monarda punctata*) has been shown to have a fertilizer value such that, if returned to the soil, it would restore most of the nutrient materials removed by this crop. During the past year a study has been made of the waste resulting from the distillation of camphor and its effect on the soil.

*Assignment.*—W. W. Stockberger, G. A. Russell.

*Proposed expenditures, 1918-19.*—\$980.

### **Establishment of the Camphor Industry:**

*Object.*—The introduction of an industry in the production of camphor in the United States.

*Procedure.*—Field and laboratory experiments are conducted, including tests of the camphor content and distribution in grown trees, the experimental propagation, cultivation, and selection of the plants, the determination of the best methods of culture, and the development of improved machinery for use in the production of camphor.



*Cooperation.*—Land and buildings furnished by the Orange County (Fla.) Fair Association and individual growers.

*Location.*—Orlando and other points in Florida.

*Date begun.*—1908.

*Results.*—As a direct outcome of the department's work on camphor, several large commercial enterprises have been undertaken and many smaller plantings made, though none of the latter have yet reached the stage of active commercial operations. Data are published in the Department Yearbook for 1910. A careful study of the adaptation of camphor culture and production to conditions found in this country has led to improvements in methods of handling and in factory equipment which eliminate much expensive hand labor and otherwise materially reduce the cost of production. A camphor-harvesting machine has been devised and constructed by means of which the prunings used in the production of camphor gum can be harvested from the hedges at the rate of ten or twelve acres per day, making it possible to reduce the expensive hand labor heretofore required and also to avoid injury to the camphor trees caused by mutilation in hand pruning. This machine is being patented for the use of the public.

*Probable date of completion.*—1919.

*Assignment.*—G. A. Russell.

*Proposed expenditures, 1918-19.*—\$1,400.

### **Hop-Improvement Investigations:**

*Object.*—To improve methods of growing, curing, handling, and standardizing American hops.

*Procedure.*—This work includes a physiological study of the root disease of hops and of the influence of various fertilizers on yield and quality, the testing of different varieties to determine their relative value, a study of the cost of production with relation to the present method of handling the crop, and an investigation of the chemical constituents which determine the value of hops, with special reference to the modification of these constituents by cultural treatment.

*Cooperation.*—Land and crop facilities are furnished by hop growers.

*Location.*—Field headquarters at Perkins, Cal.; test of areas under special handling in Oregon and field investigations throughout the hop-growing regions of the Pacific-coast States and New York; and laboratory studies at Washington, D. C.

*Date begun.*—1905.

*Results.*—Results have been published in Farmers' Bulletin 304, Bureau of Plant Industry Circulars 33, 56, and 112, Bureau of Plant Industry Bulletins 121, part 4, and 271, and Department Bulletin 282. The hop-improvement studies have made it possible to outline a practical improvement in field methods, resulting in substantial gains in production, while progress toward the establishment of rational and uniform standards of hop valuation has resulted from the laboratory studies of hop constituents. The study of the effect of various fertilizers upon growth has been continued and data also obtained on the influence of fertilizers upon the resin content of hops. An investigation on the occurrence of arsenic in hops, in cooperation with the Bureau of Chemistry, has been completed. As a result of this investigation it was shown that the sulphur used in curing hops contained arsenic, while all other suspected sources of contamination were excluded, leaving little, if any, doubt that impure sulphur alone is responsible for the contamination of hops with appreciable quantities of arsenic.

*Assignment.*—W. W. Stockberger.

*Proposed expenditures, 1918-19.*—\$300.

### **Red-Pepper Cultivation:**

*Object.*—The introduction of an industry in the culture of red peppers for the spice markets.

*Procedure.*—Cultural tests of red-pepper varieties are made with reference to yield, disease resistance, quality of product, etc., and experiments conducted dealing with special methods required in growing, handling, curing, and marketing this crop.

*Cooperation.*—Practical farmers.

*Location.*—South Carolina.

*Date begun.*—1908.



*Results.*—Data on paprika culture published in Department Bulletin 43. The successful introduction of paprika culture indicates the possibility of the profitable introduction of the hotter cayenne varieties of red pepper. During the past year small experimental plantings of several hot peppers have given promising results. The Japanese capsicum, Japanese chili, and the long red cayenne varieties gave fair yields and very desirable products. Plantings on a field scale were made for commercial tests.

*Probable date of completion.*—The work on the paprika type of peppers is completed and the crop established; experiments with the hotter varieties of red pepper will probably be completed in 1920.

*Assignment.*—T. B. Young.

*Proposed expenditures, 1918-19.*—\$2,190.

### **Ginger-Growing Investigations:**

*Object.*—To study the propagation, handling, curing, and testing of varieties of ginger and to determine the possibilities of establishing the production of ginger on a commercial scale in the United States.

*Procedure.*—Varieties of ginger are tested and their cultural requirements determined. Methods of propagation, handling, curing, and preparation for market are being worked out.

*Location.*—Orlando, Fla.

*Date begun.*—1916 as a separate project; preliminary cultural studies in progress for several years prior.

*Results.*—A number of varieties have been tested and observations made on their adaptability to conditions in the southeastern United States. During the past year the number of varieties being tested has been increased, and the propagation stock has been multiplied as rapidly as possible to provide material for larger plantings.

*Probable date of completion.*—1921.

*Assignment.*—G. A. Russell.

*Proposed expenditures, 1918-19.*—\$200.

### **Investigations of Plants Yielding Tannins and Dyes:**

*Object.*—To investigate the value and suitability for commercial use of plants yielding tannins and dyes; to determine what plants may be collected or grown successfully in the United States and profitably utilized as sources of tannins and dyes.

*Procedure.*—Information regarding the different plants yielding tannins and dyes is accumulated and indexed. Tests of plant materials are made in cooperation with practical tanners and dye manufacturers. Cultural trials are made with certain species to determine the possibilities for their commercial production.

*Location.*—Washington, D. C., and various States.

*Date begun.*—1908. The investigations on tannins and dyes were separate projects until 1912, when they were included in the work under the project "Miscellaneous Field and Laboratory Work on Drug and Related Plants."

*Results.*—Data have been accumulated and much information disseminated regarding sources, methods of production and handling, value, and future possibilities of numerous tannin and dye plants. To meet the unprecedented demand of this year for information relative to natural dyestuffs, many circular letters have been prepared and distributed. Plantings of indigo, woad, and madder were made with a view to establish a supply of seed, should the production of those plants become necessary.

*Assignment.*—W. W. Stockberger.

*Proposed expenditures, 1918-19.*—\$790.

### **Collection of Information on the Production and Uses of Drug and Related Plants:**

*Object.*—To assemble information relating to the production and uses of drug and related plants, with special reference to sources, collection or cultivation, preparation, etc., as well as to cultural range and commercial production.

*Procedure.*—Data are secured through correspondence, reference to books and serial literature, and from small experimental cultures at Arlington Farm, Va., and elsewhere in the United States.

*Cooperation.*—Correspondents, farmers, schools of pharmacy, periodicals, and dealers.



*Location.*—Washington, D. C., and various points throughout the United States.

*Date begun.*—1913.

*Results.*—Much information has been indexed and abstracted and numerous circular letters prepared. Publications include a number of bulletins on native medicinal plants and on drug-plant culture. A summary of the drug-plant situation will be found in the article on "Production of Drug-Plant Crops in the United States," published in the 1917 Yearbook of the Department. Changed economic conditions resulting from the continuation of the war, interference with imports, and increased demand for certain drugs and related products has stimulated widely increased interest in the possibility of introducing drug-plant culture in this country. An unusually heavy demand from all parts of the country for information on the cultivation and handling of drug and related crops has been supplied through bulletins, circulars, and correspondence. It has been possible in many cases to assist growers in undertaking the culture of these crops on a commercial scale and in successfully introducing them in the market; in many other cases information designed to save expense and effort along wasteful and unproductive lines has been furnished.

*Assignment.*—W. W. Stockberger.

*Proposed expenditures, 1918-19.*—\$540.

#### **Miscellaneous Field and Laboratory Work on Drug and Related Plants:**

*Object.*—This project covers a large number of preliminary investigations and minor problems, including a study of small experimental cultures of numerous drug and related plants and miscellaneous laboratory studies dealing with the value and utilization of the products.

*Procedure.*—Small experimental cultures of drug and related plants are maintained at testing stations. In general, these tests comprise preliminary trials, which require careful attention in the field and collaboration with laboratory assistants. A variety of laboratory problems not having project rank, involving technical studies of drug and related plants, are worked out.

*Cooperation.*—University of Wisconsin, at Madison, Wis., and Orange County Fair Association, Orlando, Fla.

*Location.*—Washington, D. C.; Arlington Farm, Va.; Glenn Dale, Md.; Timmons ville, S. C.; Madison and Fond du Lac, Wis.; and Orlando, Fla.

*Date begun.*—1902.

*Results.*—As a feature of the work at Arlington Farm, Va., permanent plantings have been made, which will furnish greatly needed authentic material for standardizing crude drugs. At Glenn Dale, Md., the adaptability of sandy loam has been satisfactorily tested and plantings made on a scale sufficiently large to afford data of commercial value. In the work of the testing gardens observations have been made on the cultivation and methods of handling of more than 170 species of drug and related plants. Special attention has been given to the cultural problems of belladonna, henbane, and digitalis, three important drugs which have become scarce in the market and high in price. Substantial additions of authentic material of drug plants have been furnished to the economic herbarium of the bureau. Propagating materials of over 100 species of drug plants were supplied to various schools of pharmacy, where medicinal-plant gardens have been started.

*Assignment.*—W. W. Stockberger, A. F. Sievers, Thos. B. Young, G. A. Russell.

*Proposed expenditures, 1918-19.*—\$4,390.

**Total, Drug and Related Plants and Their Products, \$27,430, including \$3,920 statutory.**

#### **POISONOUS-PLANT INVESTIGATIONS.**

##### **Geographical Distribution and Localization of Poisonous Plants:**

*Object.*—To study the geographical distribution and localization of poisonous plants, with special reference to those areas in which, owing to their abundance or concentration, they are believed to be especially harmful.



*Procedure.*—Botanical reconnoissances are made in areas where harmful plants are believed to be present, suspected plants collected for identification, and the distribution and abundance of those believed to be poisonous plotted.

*Cooperation.*—Bureau of Animal Industry.

*Location.*—Washington, D. C., and various other points.

*Date begun.*—1915.

*Results.*—Data relating to the identity, distribution, and abundance of poisonous plants have been collected and made available to the Bureau of Animal Industry and the Forest Service. The work of the past year has consisted chiefly of poisonous plant surveys on the national forest ranges in South Dakota, Oregon, Washington, Idaho, Minnesota, and Utah. In view of the threatened scarcity of digitalis and the very great importance of securing supplies of this drug, a survey was also made of areas of digitalis growing wild in the Northwest, and material from these wild plants was collected for a laboratory study of its active-principle content.

*Assignment.*—W. W. Stockberger, W. W. Eggleston.

*Proposed expenditures, 1918-19.*—\$2,500.

### Miscellaneous Studies of Poisonous Plants:

*Object.*—To study poisonous plants with reference to the nature and pharmacological action of their constituents, methods of eradication, means of avoiding plants harmful to man, etc.

*Procedure.*—The work involves field and laboratory studies of suspected plants.

*Cooperation.*—Bureau of Entomology.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—Work conducted in cooperation with the Bureau of Entomology on new sources of plant insecticides has included studies of about 30 species of poisonous plants to determine their value as insecticides. The work thus far has dealt principally with the plant known as "fly poison" or "crow poison" (*Amanita muscaria*) and with the use of quassia. Many experiments were made to determine the most effective method of extracting the quassia chips and preparing spraying solutions. Extensive tests on several species of aphids established the fact that quassia is not as efficient as nicotine sulphate, but that under favorable climatic conditions it is a suitable remedy for certain classes of aphids. Results published in *Journal of Agricultural Research*, vol. 10, No. 10, "Quassia Extract as a Contact Insecticide," and in an article on "Poisonous Plants as Possible Sources of Insecticides," published in a technical periodical.

*Assignment.*—W. W. Stockberger, A. F. Sievers.

*Proposed expenditures, 1918-19.*—\$275.

**Total, Poisonous-Plant Investigations, \$2,775.**

### INVESTIGATIONS IN PLANT PHYSIOLOGY AND FERMENTATION.

#### Physiological Action of Solutions of Organic and of Inorganic Substances on Crop Plants:

*Object.*—To ascertain the fundamental requirements made by plants upon the medium in which they live.

*Procedure.*—Studies are made of the function and growth of crop plants in water cultures and sand cultures made up with mixed solutions of organic and inorganic materials the action of which on plant growth is to be determined. The work is carried on under carefully controlled physiological conditions, through the use of laboratory and greenhouse methods.

*Location.*—Washington, D. C.

*Date begun.*—1908.

*Results.*—Study of the physiological requirements of crop plants has yielded important data on the proportions of nutrient materials necessary to support plant life and on the rôle of calcium and other inorganic chemicals in plant metabolism. Clearer knowledge of the different food requirements of various kinds of crops, which is being gained through



these studies, promises to afford a more rational basis for supplying the needs of crops grown on various types of soil. Owing to the potash shortage, the availability of the potassium found in greensand deposits of the Coastal Plain has been given chief attention during the past year. It has been shown by analysis that potassium is present in these materials in quantities as high as 7 per cent. The availability of this potassium has been shown by pot experiments with wheat and red clover to be sufficient to supply immediate demands in quantities from 5 to 10 tons of good marl to the acre-foot. How long this application will suffice is not known. To judge from farm records of the past, it will be sufficient for several years certainly. The importance of using some lime with greensands lacking shells is indicated. The results of this work have been in part formulated for publication. Other results, including studies of the behavior of different types of crop plants to different calcium compounds, have been published in a number of articles in technical periodicals.

*Assignment.*—R. H. True, F. W. Geise, O. F. Black.

*Proposed expenditures, 1918-19.*—\$2,500.

### **Physiological Study of Injury to Plants by Low Temperatures:**

*Object.*—To ascertain the fundamental nature of the changes produced by low temperatures in plants, and to learn the causes of "hardening off" and of susceptibility to frost; also to ascertain the nature of the changes taking place in the "hardening off" of plants.

*Procedure.*—This project includes a study of injury to plants by low temperatures following different types of preparatory treatment, such as preliminary "hardening off" and treatment with various types of fertilizer mixtures. Plants are exposed to various degrees of cold and biochemical studies made of the constitution and concentration of their juices, as well as microscopical studies of the plant tissues. It is hoped that as a result of these studies light may be thrown on the cause of injury and means discovered by which such injury may be reduced.

*Location.*—Washington, D. C.

*Date begun.*—1916.

*Results.*—The "hardening off" of tender plants is accompanied by an increased proportion of the amino acids compared with proteids. The formation of certain tumors as the result of frost injury is succeeded by the precipitation of calcium phosphate in the cells from which the tumors take their origin. The results of this investigation have been reported in a manuscript which has been submitted for publication in the Journal of Agricultural Research.

*Assignment.*—R. B. Harvey, F. W. Geise.

*Proposed expenditures, 1918-19.*—\$1,350.

### **Physiological Study of the Effects of Storage on Fruits and Vegetables:**

*Object.*—To study the physiological behavior of sweet potatoes, onions, and other vegetables, also fruits, during storage under various conditions, with a view to determine the reason for physiological weaknesses developed during and after storage.

*Procedure.*—Vegetables and fruits are stored at different temperatures for various lengths of time, and biochemical and physiological studies are made of samples of the material taken at different stages of the experiments, in the hope of learning what changes take place during storage and with what result. These investigations are supplemented by field observation and microscopic study.

*Location.*—Washington, D. C.

*Date begun.*—1909.

*Results.*—Previous investigations have shown that the sweet potato contains very little sugar while growing in the ground, the reserve material being almost wholly in the form of starch. During storage at 50° to 60° F. a rapid transformation of starch to cane sugar, with the formation of some glucose, takes place, the maximum cane-sugar content being about 7 per cent. At 38° to 40° F. the cane-sugar content rises much higher, but the potatoes then become susceptible to the attack of organisms and decay. In the destruction of reserve material by respiration only the starch and glucose are affected, the cane sugar being relatively stable.



Study of the changes in the sweet potato in the ground during the later part of the growing season was undertaken with the view of obtaining criteria by which the state of ripeness of the roots might be judged. No chemical changes were found, the roots having a remarkably uniform composition, indicating that the sweet potato does not undergo a definite process of ripening characterized by the transformation of one constituent into another. After the leaves are frozen, however, water accumulates in the roots, sometimes increasing nearly 5 per cent, and this high water content is detrimental to the storage of sweet potatoes.

The effect of various pressures of oxygen and air upon carbohydrate transformations was studied, since these transformations accompany susceptibility to disease, and it has been generally found that cane sugar is not produced in the absence of oxygen. Excessive oxygen killed the sweet-potato roots, and under no pressure of oxygen or air did sugar accumulation cease. Even in the absence of oxygen, contrary to expectation, cane sugar was formed.

Results published in *Journal of Agricultural Research*, vol. 3, No. 4, vol. 5, Nos. 12 and 13, and vol. 12, No. 1; a manuscript entitled "Effect of Different Oxygen Pressures on the Carbohydrate Metabolism of the Sweet Potato" has also been submitted for publication in the *Journal*.

*Assignment.*—H. Hasselbring.

*Proposed expenditures, 1918-19.*—\$3,040.

### **Physiological Study of the Relation of Oxidizing Enzymes to Plant Diseases:**

*Object.*—To devise a practical method of ascertaining variation in oxidase content in normal and diseased plants, and to investigate the relation of oxidase action to certain important plant diseases.

*Procedure.*—Methods and apparatus for determining oxidase action are devised, and by means of these investigations in the field and laboratory of oxidase action in normal and diseased plants are made.

*Location.*—Washington, D. C.

*Date begun.*—1909.

*Results.*—Methods of measuring oxidase action, making it possible to investigate the significance of the oxidase enzymes in normal and diseased plants, have been developed. Results published in *Bureau of Plant Industry Bulletins* 238 and 277, *Journal of Agricultural Research*, vol. 2, No. 5, and technical papers in scientific periodicals. A paper on the oxidase reaction in normal and in blighted spinach is in manuscript ready to be submitted for publication.

*Assignment.*—R. B. Harvey.

*Proposed expenditures, 1918-19.*—\$1,150.

### **Physiological Study of Molds and Their Relation to the Deterioration of Plant Products:**

*Object.*—To investigate the physiology of molds with special reference to the products of their metabolism, with the view of determining their conditions of life and the effect of the products which they elaborate.

*Procedure.*—Molds concerned in the deterioration of seeds, grains, and other plant products are cultivated in pure cultures and in culture media composed of these plant products. A study is made of the products of the activity of these organisms with reference to their chemical and physiological properties, possible toxicity, etc., and of plant products from ordinary sources with reference to the presence of these substances.

*Location.*—Washington, D. C.

*Date begun.*—1909.

*Results.*—A method of determining the degree of deterioration in corn by the acidity test has been devised and is now generally adopted by health boards, corporations, and by the Bureau of Markets. The action of molds growing on spoiled corn has been studied with special reference to the development of toxic substances, and a toxic product has been isolated from cultures of *Penicillium puberulum*. Results published in *B. P. I. Bulletins* 199 and 270. Investigation of the mold *Aspergillus flavus*, found in moldy corn, has been undertaken. A phenolic acid elaborated by this mold has been isolated, and cultures are being grown on a sufficiently large scale to get enough of this compound to make a thorough study of it.

*Assignment.*—O. F. Black.

*Proposed expenditures, 1918-19.*—\$850.



**Physiological Study of Plant Parasites, Especially in Relation to the Plant Attacked:**

**Object.**—To investigate the physiology of parasitic organisms with special reference to the products of their metabolism, their mode of attack, and the physiological results produced in the plants attacked by them.

**Procedure.**—The parasitic organisms concerned are cultivated in the laboratory, and the biochemical changes produced in culture media and in host plants by these organisms are studied. A study is made of the enzymes produced, the toxic substances formed, and the effect produced on the behavior of the host plant as seen in its modified chemical constituents. The work is carried on in cooperation with the Offices of Cotton, Truck, and Forage-Crop Disease Investigations, Fruit-Disease Investigations, and Forest Pathology, of this bureau.

**Location.**—Washington, D. C., supplemented by field studies at other points.

**Date begun.**—1914.

**Results.**—Chemical studies on the effect of certain parasitic fungi on their host plants have shown that some constituents of the plants are attacked by the parasites while others are not. As an example, the starch of the potato is not broken down by certain tuber-rotting fungi, but the sugar is all used. A method of fumigating seed, which was devised in cooperation with the Federal Horticultural Board and published in Department Bulletin 186, has since developed commercial importance, having been adapted to practical use on a large scale. Studies of the utilization of certain pentoses and compounds of pentoses by *Glomerella cingulata*, also on some effects of the brown-rot fungus, and on coloring matters of the chestnut-blight fungus and related fungi, have been published in scientific periodicals. The results of investigations demonstrating the cause of potato leak were published in the Journal of Agricultural Research, vol. 6, No. 17. The manner in which the organism causing this disease gains access to the potato tubers has been ascertained, methods of controlling the disease demonstrated, and chemical studies of resistant and nonresistant varieties of potatoes carried out. The results of the work are in manuscript ready to submit for publication. Other studies completed include those on the comparative osmotic pressure of a number of common parasitic fungi and their host plants, published in the Journal of Agricultural Research, vol. 7, No. 5; effect of certain tuber rots on the composition of the potato, published in the Journal of Agricultural Research, vol. 6, No. 5; studies of Rhizopus rot in strawberries and of the relations between various fruits and vegetables and organisms which attack them, published in scientific periodicals outside the department.

**Assignment.**—R. H. True, Lon A. Hawkins.

**Proposed expenditures, 1918-19.**—\$2,150.

**Physiological Study of the Chestnut Tree and Other Plants:**

**Object.**—To determine the nature of physiological changes produced in the chestnut tree and in spinach and other plants as a result of diseased conditions, in the hope of finding means of combating the diseases.

**Procedure.**—Physiological and biochemical studies of normal and diseased plants are made.

**Location.**—Washington, D. C., Norfolk, Va., and other points.

**Date begun.**—1915.

**Results.**—Studies of the organic and inorganic constituents of normal and diseased chestnut bark have been carried out. Factors of error in current methods of determining phosphorus, as well as other problems encountered in estimating certain constituents important in plant metabolism and occurring in minute amounts in the plant materials under investigation, have necessitated preliminary work in the improvement of microchemical and microbiological methods. The results of these studies have been disseminated through seven technical papers published in scientific periodicals. It has been shown that blighted spinach is capable of making proteids but is at the same time robbed of nitrogen by a denitrifying process taking place coincidentally in the plant. This latter process is doubtless due to the action of the agent producing the disease. The results have been collected in a paper entitled "The Nitrogen Metabolism of Normal and of Blighted Spinach" proposed for the Journal of Agricultural Research.

**Assignment.**—S. L. Jodidi, H. G. Higgins, R. R. Fulton.

**Proposed expenditures, 1918-19.**—\$5,480.



**Physiological Study of Germination:**

*Object.*—To investigate the fundamental physiology of the germination of seeds, tubers, and other reproductive plant structures.

*Procedure.*—Seeds, bulbs, tubers, etc., are studied before, during, and after germination under various chemical and physical conditions under careful laboratory control, and tests are made of enzyme activities in seeds and seedlings. These experiments are conducted in cooperation with the Seed-Testing Laboratory of the bureau.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—A study of the enzymes present in seeds has been begun, the oxidases and catalases having received detailed attention. The relations of the intensity of these enzyme reactions to a variety of conditions and their distribution in different parts of the seed of Johnson grass, wheat, and many other plants have been studied. Their relation to degree of maturity, the effect of drying—even to an extreme degree—the effect of exposure to high and low temperatures, the effect of long keeping, the relation of these reactions to after-ripening of the seed, the relation to germination changes, and the relation to respiratory activity are some of the points investigated. These results are collected for publication under the title "Catalase and Oxidase Content of Seeds in Relation to Their Dormancy, Age, Vitality, and Respiration" in a manuscript which is being submitted for publication in the Journal of Agricultural Research.

*Assignment.*—William Crocker, George T. Harrington.

*Proposed expenditures, 1918-19.*—\$1,500.

**Study of the Ash Constituents of Spinach and Other Plants in Relation to Conditions of Disease:**

*Object.*—To ascertain the modifications in metabolism of spinach and other plants arising in conditions of disease, including the utilization by the plants of fertilizer constituents under a variety of field conditions, with a view to remedy abnormal physiological conditions by the use of plant nutrients.

*Procedure.*—The work under this project involves the cultivation of spinach and other plants subject to physiological diseases under conditions likely to produce them and a study of the effect of a modification of the nutrition of these plants with reference to the removal of the cause of the trouble. These investigations deal with a series of abnormal conditions which are known as physiological diseases and are frequently supposed to be due to faulty nutrition. The plant materials grown under these various conditions are subjected to a thorough biochemical study in the laboratory in the hope of finding out in what ways the processes of the plants are interfered with by conditions producing disease. The work is carried on in cooperation with the Office of Cotton, Truck, and Forage-Crop Disease Investigations of the Bureau of Plant Industry.

*Location.*—Washington, D. C., and Norfolk, Va.

*Cooperation.*—Virginia Truck Experiment Station, Norfolk, Va.

*Date begun.*—1915.

*Results.*—A comparative study of the ash constituents in normal and in blighted spinach shows several points of difference which may or may not be significant. It is likely that they are not fundamental but go with more fundamental disturbances in other ways. A paper presenting the details, under the title "Ash Constituents of Normal and of Blighted Spinach," is ready to submit for publication.

*Assignment.*—R. H. True, O. F. Black.

*Proposed expenditures, 1918-19.*—\$1,940.

**Physiological Investigation of Mosaic Diseases:**

*Object.*—To study the physiological relations involved in the cause, method of operation, and control of the mosaic disease as affecting potato and tomato plants.

*Procedure.*—Physiological and biochemical studies are made, in field and laboratory, of normal and diseased plants. The work is carried on in cooperation with the Office of Cotton, Truck, and Forage-Crop Disease Investigations of this bureau.

*Location.*—Washington, D. C., supplemented by field studies at other points.

*Date begun.*—1917.



*Results.*—This work was carried on during the early part of the past season in laboratory and field, and some results were obtained which seemed to show that the mosaic disease of potatoes as seen in Maine is communicable. Promising means of protecting the crop were under consideration when the transfer of the project leader to another office and the resignation of his assistant to enter the Army interrupted the work. It is planned to resume it as soon as their successors can be appointed.

*Assignment.*—R. H. True, Lon A. Hawkins, F. M. Hildebrandt.

*Proposed expenditures, 1918-19.*—\$2,050.

### **Physiological Investigation of the Effects Produced in Plants by the Cyaniding Process:**

*Object.*—To learn the conditions under which cyaniding may be carried on without injury to plants; also to study the effects, good and bad, which come from the cyaniding process as practiced in the greenhouse and in the field.

*Procedure.*—Plants which have been cyanided under various conditions and in various degrees of intensity are compared in their anatomical, physical, and chemical characteristics with similar plants not so treated.

*Cooperation.*—Bureau of Entomology and University of Minnesota.

*Location.*—Washington, D. C., supplemented by field work at various points.

*Date begun.*—1917.

*Results.*—Experiments undertaken thus far show clearly that the stomata are the principal paths of entrance for hydrocyanic-acid gas. Little or no penetration takes place through other parts of the epidermis. This is, of course, the basis for fumigating at night or on dark days when the stomata are closed. Those varieties of plants having the greatest quantity of anthocyanins are most easily injured, as shown by the green and purple varieties of tradescantia. Where there are local differences in the quantities of anthocyanins in different parts of the leaf, greatest injury occurs in the pigmented areas, as shown in the petiole of tomato. Sensitiveness to hydrocyanic-acid gas is paralleled by greater sensitiveness to hydrochloric-acid gas than to ammonia fumes in the purple tradescantia. The green variety of tradescantia is more resistant to these gases than the purple variety and more sensitive to ammonia fumes than the latter. This indicates that there is a relation existing between acid-combining power and injury from hydrocyanic-acid gas.

*Assignment.*—R. B. Harvey.

*Proposed expenditures, 1918-19.*—\$700.

### **Physiological Study of the Causes of Immunity to Disease in Plants:**

*Object.*—To ascertain how far immunity to disease in plants is due to biochemical causes, with the hope that means for increasing resistance may be developed.

*Procedure.*—Tests are made in the laboratory on resistant and non-resistant strains of plants, supplemented by cultures in the greenhouse and in the field.

*Location.*—Washington, D. C.

*Date begun.*—1918.

*Results.*—During the year work has been done on the cause of varietal resistance of Irish potatoes to *Pythium* in California. It appears that a considerable difference exists in the thickness of the cell walls in the tubers. The varieties having thin walls are more readily penetrated by the parasite and develop the disease, while the thick-walled sorts, through their impenetrability by the fungus hyphæ, are relatively immune to attack. A paper bringing these results together is being prepared.

*Assignment.*—R. H. True, O. F. Black, Lon A. Hawkins, R. B. Harvey.

*Proposed expenditures, 1918-19.*—\$2,890.

### **Miscellaneous Investigations in Plant Physiology and Fermentation:**

*Object.*—To handle miscellaneous minor matters in the conduct of general plant physiological and fermentation investigations.

*Procedure.*—Investigations are carried on in the laboratory, field, and greenhouse by specialists, using technical methods. Preliminary investigations conducted here lead to the submittal of definite projects where the problems concerned prove to be of project rank.

*Location.*—Washington, D. C.

*Date begun.*—1909.



*Results.*—Investigations of pigments of fruits, vegetables, and other plant products are being carried out in cooperation with the Office of Pomological and Horticultural Investigations. Results of miscellaneous investigations conducted under this project have been published in Department Bulletins—109, "The Molds of Cigars and Their Prevention," and 182, "Agricultural Alcohol; Studies of Its Manufacture in Germany," and 12 papers in scientific periodicals dealing with heredity and variation in plants. Other results published in technical periodicals include a paper on "The Separation of Autogenous and Added Hydrocyanic Acid from Certain Plant Tissues and Its Disappearance During Maceration." Work on the cause of acidity in dasheens and other aroids used for food purposes has shown that this effect is due to irritation, chiefly mechanical, produced by minute needle-shaped crystals of calcium oxalate. When by means of cooking the processes of coagulation of the cell contents prevent the escape of these crystals from the cells, the acidity is lost.

*Assignment.*—R. H. True, O. F. Black.

*Proposed expenditures, 1918-19.*—\$3,866.

**Total, Investigations in Plant Physiology and Fermentation, \$29,466, including \$720 statutory.**

**Total, Drug Plant, Poisonous Plant, Physiological and Fermentation Investigations, \$73,320, including \$14,500 statutory.**

[Research.]

## AGRICULTURAL TECHNOLOGY INVESTIGATIONS.

### Supervision:

*Object.*—To conduct administrative work, including routine clerical and laboratory duties.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Assignment.*—N. A. Cobb, W. E. Chambers, Albert Mann.

*Proposed expenditures, 1918-19.*—\$10,840.

### Free-Living and Plant-Infesting Nematodes:

*Object.*—To improve the methods of treating land and crops so as to diminish the losses due to attacks of nematodes, including the technological study of the nematodes themselves, their species, life history, and general economic relationships.

*Procedure.*—This project involves a study of the nature, distribution, and economic relationships of nematodes parasitic in plants or attacking plants and the application of the knowledge so acquired to the study of their attacks on plants, with the object of lessening the damage caused thereby.

*Cooperation.*—Individual growers in various States, other officers of the department and other branches of the Government, universities, colleges, and State governments.

*Location.*—Washington, D. C.; practically every State.

*Date begun.*—1906.

*Results.*—Studies of the gall worm, *Heterodera radiculicola*, have been continued. Hundreds of samples of roots of plants have been examined, and evidence is constantly accumulating that this serious pest is much more common in gardens than has hitherto been supposed, especially from the latitude of Washington southward. As a means of combating this pest in vegetable gardens, under certain conditions, a rotation with chickens has been tried out and is now recommended, and a special notice dealing with the subject has been prepared for distribution through the Office of Information.

With the object of ascertaining something definite about the nematode fauna of the soil, arrangements have been made with various experiment stations by which examinations have been made of the soil of plats which have been kept under the same crop for a long period of years. These investigations are progressing favorably.

From experiments conducted at the Arlington Farm definite information has been obtained with regard to the relationship of certain nematodes to certain soil conditions.



Systematic, quantitative experimental observations on sugar-beet plants and their infestation with *Heterodera schachtii* have been inaugurated, in cooperation with the Office of Sugar-Plant Investigations, with a view to check up the results of efforts toward the control of this pest. Quantitative samples of soil from infested areas have been examined and the number of nematodes per acre ascertained. Examinations of imported German sugar-beet seed and its contaminations have been continued. Thus far four different species of nematodes have been discovered in this material, in some instances in a living condition, though only in one case have living adults, larvæ, or eggs, of *H. schachtii* thus far been discovered. A method of estimating the nema population of soil has been devised and published. This method applies also to the gall nema and other nemas.

Foreign soils imported, or likely to be imported, into this country are constantly being examined, with a view to ascertain new facts with regard to their nematode fauna. The results of these examinations are recorded and, as a rule, transmitted to the officers or correspondents concerned. Many new species of nematodes have thus been discovered and described and other useful information regarding nematodes obtained.

It has been discovered that not infrequently nematodes are abundant in ensilage. The numbers in which they occur suggest that they may sometimes be an important biological factor in the ensilage. Further investigation is under way.

Observations have been made and published upon the varieties of hermaphroditism that occur in free-living nematodes, and as a result the department's knowledge of this subject has been materially extended.

The *Tylenchus dipsaci* (synonym *Tylenchus devastatrix*) has been noted in new localities, and steps have been taken to warn growers of its spread and to outline methods of coping with the pest.

An article entitled "Nematodes and Their Relationships" was prepared and published in the Department Yearbook for 1914. Copies of this article in separate form have been distributed among colleges and universities of the United States, with the result that several colleges have announced their intention to introduce a special study of nematodes into their zoological courses.

A number of articles have been published in scientific journals, all of which have a more or less distinct economic bearing, and numerous lectures have been delivered on the subject of nematodes and their relationship to agriculture and to mankind.

An article entitled "The Mononchs" has been published giving a full account of the genus *Mononchus*, a genus of predatory nemas useful to agriculture. The article is specially designed to stimulate research along this line and is succeeding in its object.

As fast as definite results are obtained they are made known to other offices, such as the Federal Horticultural Board, offices having plant-introduction functions, and those associated with particular crops.

*Assignment.*—N. A. Cobb, W. E. Chambers.

*Proposed expenditures, 1918-19.*—\$11,560.

### Fiber Technology:

*Object.*—The study of fiber, especially cotton fiber, with a view to increase our knowledge of the properties of the fiber from a technological standpoint.

*Procedure.*—A study is being made of those problems lying between the farmer and the manufacturer which are essentially technological in their nature, problems in which it is necessary that the farmer and the manufacturer should better understand each other's conditions and difficulties, with the view of eliminating as far as possible unreasonable demands of manufacturers and educating the growers with regard to the qualities of their products which are essential in order that they may have the highest intrinsic, as well as economic, value.

*Cooperation.*—Various State governments, private growers, and manufacturers.

*Location.*—Washington, D. C.

*Date begun.*—1915 as a separate project; work along these lines has been going on for some years.



*Results.*—Numerous experiments have been made with regard to the physical properties of cotton fibers, concerned largely with the length and form of the fibers and their tensile strength and hygroscopic qualities, with a special view to establish a clearer understanding of the relationship of the various qualities to the uses to which they are put and of the processes they must undergo in course of manufacture. The results of these experiments have been, to a considerable extent, embodied in addresses to various associations connected with the cotton industry.

Comparisons of the twist or spirality of various cottons have been made, in order to ascertain whether this property will serve as a basis for distinguishing one cotton from another. A series of experiments upon a considerable number of cottons of the Egyptian and Sea Island varieties, including cotton crops of different years, shows an excess of left-hand twist in Egyptian and an excess of right-hand twist in Sea Island. While there are marked exceptions to the rule, the results of the experiments justify the use of this test in efforts to distinguish between these two kinds of fiber.

Tests have been carried out upon various portions of individual cotton fibers to show what portions of the fibers are strongest and what portions weakest. It remains to be discovered whether different varieties differ in this respect, though it seems hardly likely that such differences exist.

A publication of about 100 pages, copiously illustrated, appeared recently, giving some of the results of these investigations.

A considerable number of samples of fibers and fabrics have been submitted to this office for examination and report by growers and manufacturers and by officers of the department.

*Assignment.*—N. A. Cobb.

*Proposed expenditures, 1918-19.*—\$6,500.

### **Agricultural Apparatus:**

*Object.*—To investigate and improve agricultural apparatus, with a view to improved efficiency.

*Procedure.*—Continuous study is made of current apparatus with reference to its relative and absolute efficiency and with reference to its improvement, and new apparatus is devised that will be more efficient or fill needs at present not filled at all—that is, where work is at present performed by hand or in primitive ways.

*Cooperation.*—Individual farmers and experts in various States, other officers of the Government, and manufacturers.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—Many machines and pieces of apparatus have been devised and put into use in both field and laboratory. A new apparatus for estimating the number of organisms in the soil has been devised and is now in use.

A clover-seed harvester has been devised and put into operation in conjunction with the Office of Forage-Crop Investigations.

A machine for trimming bulbs has been invented, patented, and put into successful operation.

Other agricultural apparatus devised includes cotton-picking sleds for cotton-picking experiments, a device to roll cotton samples as the cotton leaves the gin, and a device to hold cotton in cartons while being sewed.

Considerable study and experimental work with regard to cotton ginning and the effect of same on cotton have been undertaken, resulting in some instances in putting into practical effect the ideas that have thus been developed. To a smaller extent this is also true of cotton pickers and cotton presses.

During the past year the activities under this project have been of the usual character, though recently they have been confined more particularly to indoor apparatus. Successful experiments have been made concerning the possibility of using vacuum bottles for the transportation of precooled material in small quantities. The catalogue file of the office relating to machinery, agricultural tools, and apparatus has been recently renewed and expanded.

*Assignment.*—N. A. Cobb, M. L. Harrison.

*Proposed expenditures, 1918-19.*—\$1,500.



**Illustrations:**

*Object.*—The production of better illustrations at lower cost.

*Procedure.*—Methods of illustration, utilizing special apparatus adapted to the quick and accurate and cheaper production of original illustrations for record and publication, are demonstrated. Apparatus has been devised specially to meet the needs of investigators and publishers.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—The more important results achieved in the past are improvements in the camera-lucida method of preparing illustrations and the devising of a small photostat; a number of methods of staining and separating under pressure to bring out certain chromosome details for the purpose of enabling better illustrations to be prepared; a simple camera for taking photomicrographs; and an improved method of utilizing the typewriter for lettering drawings and graphs.

Several recent improvements in methods of producing illustrations for publication purposes have been effected. These relate to the charting of the outline of elongated flexible objects, a practical and less expensive way of lettering drawings, etc. These methods have been applied in illustrations already published and are therefore a matter of record. They are also explained to all inquirers at the office. The illustration methods are being adapted extensively, and visitors with this idea in mind are frequent—some from important institutions.

*Assignment.*—N. A. Cobb, W. E. Chambers.

*Proposed expenditures, 1918-19.*—\$610.

**Solar and Artificial Projection:**

*Object.*—To study and devise projection apparatus for making magnification of microscopic objects and for improving illustrations and making minute measurements.

*Procedure.*—Experiments are conducted with artificial and solar projection and in methods of preparing illustrations, and such experiments are made as are suggested by the exigencies of this office as well as of other offices of the department having projection work to do and illustrations to prepare.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—The more important results achieved in the past are the following: The projector for cotton fibers has been improved in various ways and the tungsten lamps especially adapted thereto; improvements have been effected in the map measures used in measuring the projected images, and further improvements have been made in the method of testing map measures and the interest of manufacturers and dealers enlisted in carrying these improvements into practical effect; promising results have been obtained from experiments made in the reduction of heat in projection apparatus, with a view to avoid its destructive effects on lantern slides and living objects, as well as from experiments made upon aluminum screens, with the view of making the image as visible from the side of the auditorium as from the center.

As a result of recent investigations a considerable number of small but useful improvements have been made. The use of immersion lenses as condensers in camera-lucida projection work proves to be entirely satisfactory and is the best method yet devised. By this method certain results are obtainable that have not been found possible by any other known method. New screens for camera-lucida projection work have been tried and improvements introduced. A description of a number of these improvements, together with a complete and detailed description of the microscope installations used in this office, has been published. This publication was made in response to numerous requests for something of the kind preferred by the leading executive officers of some of the best-known American scientific societies. This projection outfit has been recently enlarged and otherwise improved.

*Assignment.*—N. A. Cobb.

*Proposed expenditures, 1918-19.*—\$610.



**Study of Hawaiian Fungi Other than Cane:**

*Object.*—To collect and study Hawaiian fungi other than cane, and to publish the results of this reconnoissance.

*Procedure.*—Fungi are collected and studied with the assistance, in the matter of collection, of the various Hawaiian experiment stations.

*Cooperation.*—States Relations Service, the Hawaiian Sugar Planters' Association, and various Hawaiian experiment stations.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Results.*—The only result yet obtained comes from a reexamination of a large amount of material bearing upon this investigation, indicating clearly the necessity for the research suggested along these lines.

*Probable date of completion.*—Should be completed within one year.

*Assignment.*—N. A. Cobb, E. G. Arzberger, Flora W. Patterson.

*Proposed expenditures, 1918-19.*—\$500.

**Miscellaneous Biological Technology:**

*Object.*—The performance of the large amount of work of a technological nature which this office is called upon to do for other officers of the Government and which does not properly come under the head of any of its other projects.

*Procedure.*—The work is of a very miscellaneous character. The following may be mentioned simply as instances: The investigation of diatoms, both recent and fossil, for various departments of the Government; photomicroscopy, especially of plant tissue; examination of microscopes and other optical instruments, in consultation with other officers of the Government service who wish advice in the purchase of such apparatus; and special preparation of material for microscopic study, especially in plant morphology.

*Cooperation.*—Other offices of the department, the Bureau of Fisheries, and the Geological Survey.

*Location.*—Washington, D. C.

*Date begun.*—1915, as a separate project; work of this class has been performed since the establishment of this office in 1907.

*Results.*—A much larger number of tests of the quality of microscopes and microscopic accessories has been made during this year than formerly, due to abnormal restrictions in the supply of scientific instruments. There has been a marked increase in requests from outside sources for examination of recent and fossil diatom material. Assistance rendered to other offices in the technique in plant morphology has also increased. On the other hand, work on problems of a strictly agricultural nature has somewhat declined.

*Assignment.*—Albert Mann.

*Proposed expenditures, 1918-19.*—\$1,700.

**Total, Agricultural Technology Investigations, \$33,820, including \$8,880 statutory.**

[Research.]

**BIOPHYSICAL INVESTIGATIONS.****Supervision:**

*Object.*—General supervision of biophysical investigations, preparation of data for publication, and the conduct of clerical routine.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Assignment.*—L. J. Briggs.

*Proposed expenditures, 1918-19.*—\$8,880.

**Cooperative Biophysical Investigations:**

*Object.*—To determine the effect of various methods of soil preparation and crop rotation upon the moisture content, temperature, humus content, soluble-salt content, aeration, and other physical properties of the soil, and weather conditions at the various stations in relation to crop production; also to determine by means of field and pot cultures the water requirement of the principal crop plants grown on the various reclamation projects, with a view to develop a more efficient use of water in irrigated regions.



*Procedure.*—This work involves the systematic measurement of the soil moisture and weather conditions at the various stations where field work is being conducted by the Offices of Dry-Land Agriculture Investigations, Western Irrigation Agriculture Investigations, Cereal Investigations, Forage-Crop Investigations, and Alkali and Drought Resistant Plant Investigations, all of the Bureau of Plant Industry. The Office of Biophysical Investigations outlines the method of procedure, provides the apparatus and equipment, supervises the observations, and assists in reducing the results. The field observations are for the most part made by the field staff of the cooperating offices. Special investigations are conducted in cooperation with the Office of Alkali and Drought Resistant Plant Investigations to determine the amount of water required by different crops for the production of a pound of dry matter and the effect of weather conditions upon such water requirement.

It is also proposed to study the moisture content of the soils of the experimental farms located on the reclamation projects with the view of determining the amount of water actually required in crop production under field conditions. These field measurements will also be supplemented by pot cultures.

In 1918 a cooperative arrangement was made with the Oregon Experiment Station to study the water requirement of crops in the marsh lands of that State. This work is being continued during the present year.

*Location.*—Yuma, Ariz., Biggs and Chula Vista, Cal., Akron, Colo., Aberdeen, Idaho, Colby, Garden City, and Hays, Kans., Huntley, Havre, and Judith Basin, Mont., Mitchell and North Platte, Nebr., Fallon, Nev., Tucumcari, N. Mex., Mandan, Dickinson, Williston, and Edgeley, N. Dak., Newell, S. Dak., Burns, Klamath Falls, Deschutes County, Moro, and Umatilla, Oreg., Amarillo, Big Springs, Chillicothe, and Dalhart, Tex., Nephi, Utah, Arlington Farm, Va., Archer and Sheridan, Wyo., Lawton, Okla., and Washington, D. C.

*Date begun.*—1906.

*Results.*—The results of these measurements appear in various publications of the offices mentioned, and the climatic measurements are being constantly used in connection with the investigations now in progress on the various experimental farms. The soil-moisture determinations are of especial value in determining the methods of tillage most suitable to the different conditions met with in the Great Plains. The evaporation measurements have also been very helpful in comparing and interpreting the yields obtained at the different stations in the semiarid regions as well as in studying the yields under different systems of cultivation at the same station for a period of years. The water requirement measurements have shown that plants differ greatly in the amount of water used in the production of a pound of dry plant substance, and different varieties of the same crop often exhibit marked differences in the water requirement. Other things being equal, the crop having the lowest water requirement is the one best adapted to dry-land regions, and the water-requirement measurements afford a means of selecting varieties on the basis of their efficient use of water, a matter of fundamental importance in the development of a permanent agriculture in regions having a limited rainfall.

*Assignment.*—L. J. Briggs, J. O. Belz, J. W. McLane, C. A. Jensen, A. B. Campbell.

*Proposed expenditures, 1918-19.*—\$17,820.

### **Relation of Soil Moisture and Soil Solutions to the Growth of Plants:**

*Object.*—To determine the cause of mottle-leaf, a malnutrition trouble of citrus in California and elsewhere, and to develop cultural and other methods of treatment for bringing about a normal growth. This is a serious problem in certain citrus sections of California and leads to a marked reduction in yield and ultimately to the destruction of the groves.

*Procedure.*—A field laboratory has been established at Riverside, Cal., which is in the center of the worst mottle-leaf section. Field and laboratory experiments have been actively carried on during the past four years with a view to determine the difference in the soils in the good and poor groves and to test the efficiency of certain remedial measures based upon the laboratory experiments.



*Cooperation.*—There is no official cooperation on this project, but the California Citrus Experiment Station has afforded every facility for the work within its power and for a time provided laboratory and other facilities. Hearty cooperation has also been given by many of the citrus growers, who are showing much interest in the work.

*Location.*—Headquarters at Riverside, Cal.; investigations include other citrus districts in California and Arizona.

*Date begun.*—1912.

*Results.*—Results indicate that mottle-leaf may be due to a variety of causes, but that an important contributing cause is the low humus content of the citrus soils. Experimental groves are showing improvement from the use of manure or other organic material, especially when applied as a permanent mulch on the surface of an irrigation basin around each tree.

*Assignment.*—C. A. Jensen, J. F. Breazeale, F. M. Eaton, C. J. King, J. Z. Richardson.

*Proposed expenditures, 1918-19.*—\$13,460.

**Total, Biophysical Investigations, \$40,160, including \$7,660 statutory.**

### SEED-TESTING LABORATORIES.

#### Supervision:

*Object.*—To supervise the investigational, regulatory, and clerical work of the seed-testing laboratories.

*Location.*—Washington, D. C.

*Date begun.*—1893.

*Assignment.*—E. Brown.

*Proposed expenditures, 1918-19.*—\$11,280 (research, \$10,040; regulation, \$1,240.

#### [Research.]

#### Seed Testing:

*Object.*—To test for mechanical purity and vitality samples of seed submitted by firms or individuals, and to report to them the results of such tests; to make examination of samples of seeds for the presence of adulterants or dodder; and to make identification of weed seed.

*Procedure.*—At the request of the sender samples of seed submitted to the laboratory are identified, examined for the presence of adulterants or dodder, or tested for mechanical purity or vitality. Reports are sent giving the results of the examination and other information of value to the person sowing the seed.

*Location.*—Washington, D. C., Columbia, Mo., Corvallis, Oreg., Lafayette, Ind., Berkeley, Cal., and Baton Rouge, La.

*Date begun.*—1893.

*Results.*—During the calendar year 1917, 16,505 samples, exclusive of those connected with projects "Adulterated-Seed Investigations" and "Enforcement of the Seed-Importation Act," were received. As in previous years, these samples have been examined and most of them tested for purity or germination, or both. These samples came from the following sources: Commercial samples from farmers and seedsmen, 10,689; noncommercial samples, including those used in special investigations of this laboratory and in investigational work of other offices of the bureau, 4,897; samples from the Office of Foreign Seed and Plant Introduction and the Office of Seed Distribution, 704; and samples of forage-plant seeds from custom-houses, 215. As in previous years, an effort has been made to divert to the branch laboratories samples of seeds submitted for purity and germination tests and to devote more of the work of this laboratory to investigational and general work.

*Assignment.*—E. Brown, W. L. Goss, Emma F. Sirrine.

*Proposed expenditures, 1918-19.*—\$17,680.

#### Seed Purity and Vitality Investigations:

*Object.*—To study the quality of commercial seeds; study crop seeds and the weed seeds found in them with a view to their definite identification; determine the origin of commercial seeds by means of the weed-seed content; collect and distribute authentic seeds for use in identification by comparison; develop improved laboratory methods of testing seeds for vitality; determine the agricultural value of hard seeds; study methods of



harvesting, curing, and storing best adapted to preserve vitality; and investigate the physiology and chemistry of seed germination.

*Procedure.*—Closely related groups of seeds are studied, and the characters by which they can be distinguished are described and illustrated. Weed seeds found in seeds of foreign origin are studied, described, and illustrated as a means of determining the place of origin of imported seeds. Various kinds of commercial seeds are examined from time to time, and publications are issued calling attention to any unusual conditions of quality or origin. Weed seeds and economic seeds are put up in sets and sent to schools and individuals on payment for the containers. The physiological and chemical factors are being critically studied in determining the fundamental processes of seed germination. The latter work is being carried on in cooperation with the Office of Physiological and Fermentation Investigations.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Results.*—The distinguishing characters of the seeds of the bent grasses have been worked out and published. Some 500 sets of 100 samples each of economic seeds for the use of schools have been prepared and distributed. The work on germination has included a study of the catalase and oxidase activity in seeds as effected by moisture, temperature, and reagents.

*Assignment.*—F. H. Hillman, G. T. Harrington.

*Proposed expenditures, 1918-19.*—\$7,660.

#### **Adulterated-Seed Investigations:**

*Object.*—To publish information as to the extent of the sale of adulterated or misbranded forage-plant seeds, including the analyses of such seeds, with the names and addresses of the dealers selling them.

*Procedure.*—Each year about 50 agents of the department are appointed who as individuals purchase seed in the usual course of trade. These samples are analyzed and, when found to be adulterated or misbranded, the analyses, together with the names and addresses of the persons or firms selling the seeds, are published.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Results.*—During the calendar year 1917, 445 samples of seed of redtop were collected. This seed was found to be much freer from adulteration than in previous years.

*Assignment.*—E. Brown.

*Proposed expenditures, 1918-19.*—\$7,280.

#### **[Regulation.]**

#### **Enforcement of the Seed-Importation Act:**

*Object.*—The enforcement of the seed-importation act of August 24, 1912, as amended August 11, 1916, the object of this act being to prohibit the importation into the United States of certain specified seeds when adulterated or unfit for seeding purposes.

*Procedure.*—All lots of imported forage-plant seeds specified in the act are sampled by customs officers and the samples forwarded to the nearest district seed-testing laboratory. The samples are examined and the customs officers directed to release or refuse delivery of the shipment according to whether it does or does not conform to the requirements of the act.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—During the past year samples of 1,122 lots of imported seeds subject to the seed-importation act were examined and 122 lots were prohibited entry. The greater part of the seed in the prohibited shipments was permitted entry after recleaning, several lots were exported, and some lots low in germination were denatured for feeding purposes.

*Assignment.*—E. Brown.

*Proposed expenditures, 1918-19.*—\$5,220.

**Total, Seed-Testing Laboratories, \$49,120, including \$12,440 statutory (research, \$42,300; regulation, \$6,820).**



## [Research.]

## CEREAL INVESTIGATIONS.

## SUPERVISION.

## Supervision:

*Object.*—To direct field investigations and laboratory studies, and to supervise clerical work, including correspondence, preparation of manuscripts and reports, financial records, maintenance of property and supplies, preparation of photographic material, maintenance of miscellaneous files and herbaria, seed distribution, and the general details connected with the field and laboratory investigations.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—C. R. Ball.

*Proposed expenditures, 1918-19.*—\$15,500, including \$4,840 statutory.

# PRODUCTION AND IMPROVEMENT OF CEREALS, FLAX, AND BROOM CORN AND THEIR PRODUCTS.

## Wheat Investigations:

*Object.*—To determine varietal adaptations and the factors influencing them; improve the crop through selections and hybridization of varieties and races; study and improve production methods; study inheritance in the wheat plant; and identify, describe, and classify varieties.

*Procedure.*—Varieties and races are tested on replicated field plats to determine yielding power, adaptation, and proper dates, rates, depths, and methods of seeding. Selections of promising individuals from existing varieties and in progenies of hybrids are made and compared and the best increased. Crosses are made to combine desirable characters and to study the phenomena of inheritance. Other inheritance studies within pure lines are in progress. All available domestic and foreign varieties and strains are obtained, grown in nurseries, studied, preserved in herbaria, described, and classified.

*Cooperation.*—State experiment stations in Georgia, Idaho, Iowa, Kansas, Minnesota, Missouri, Montana, New York (Cornell), North Carolina, North Dakota, Oregon, South Dakota, Tennessee, Utah, and Washington; Amarillo (Tex.) Board of City Development and Wyoming Board of Farm Commissioners.

*Location.*—Chico, Cal., Akron, Colo., Athens, Douglas, and Tifton, Ga., Aberdeen, Idaho, Ames, Iowa, Hays and Manhattan, Kans., St. Paul, Minn., Columbia, Mo., Havre and Moccasin, Mont., Ithaca, N. Y., Raleigh, Statesville, and Swannanoa, N. C., Dickinson, Mandan, and Williston, N. Dak., Burns and Moro, Oreg., Brookings, Cottonwood, Eureka, Highmore, and Newell, S. Dak., Knoxville, Tenn., Amarillo, Tex., Nephi, Utah, Arlington Farm, Va., Lind, Wash., and Archer and Sheridan, Wyo.

*Date begun.*—1890.

*Results.*—Results published in Bureau of Plant Industry Circulars 12, 59, 61, and 79; Bureau of Plant Industry Bulletins 3, 70, 178, 240, 269, and 283; Department Yearbook Separates 195, 511, and 649; Department Bulletins 30, 33, 39, 157, 270, 297, 336, 357, 398, 400, 402, 430, 450, 498, and 618; and Farmers' Bulletins 139, 466, 534, 596, 616, 678, 680, 732, 738, 749, 769, 786, 800, 878, 883, and 885.

In the fiscal year 1918 there were published in Department Bulletin 618 the principal accumulated experimental data on yields of durum wheat in the United States. It contains the statistics of production, varietal relationships, results of experiments at 30 field stations, and a bibliography. Several new Farmers' Bulletins were issued during the past year. They contain information on adapted varieties and methods of culture for different sections, as follows: Farmers' Bulletin 885, for the Southeastern States; Farmers' Bulletin 878, for western North and South Dakota; and Farmers' Bulletin 883, for dry farms in Utah.

Experiments in improving the yield and quality of wheats by breeding and selection are being continued with good results. New strains and varieties thus developed have been carefully compared and the best distributed, as, for example, Acme, Buford, and Monad, high-yielding and rust-resisting durum wheats. The varietal experiments continued from year to year make it possible to give more specific advice to farmers in



bulletins and in correspondence. Milling and baking experiments on a large number of varieties grown throughout a wide area are now in the fourth year and provide valuable information on varietal values and adaptation. A large fund of information on varietal distribution has been obtained through a varietal survey made in cooperation with the Bureau of Crop Estimates. The combined results of the varietal survey and experiments to determine varietal adaptation and milling and baking value have made it possible to recommend with certainty the varieties which should be grown in the different sections of the country.

Unusual interest in wheat production has been created by the international wheat shortage. The need for maximum production makes it especially important to grow only the best adapted varieties in all wheat-producing districts and to eliminate unadapted varieties. Considerable time and effort has been devoted to assisting the Department Seed Stocks Committee in locating sufficient supplies of seed of spring wheat, in determining their varietal purity, and in bringing such stocks to the attention of farmers needing seed wheat.

The classification and description of American wheat varieties is progressing. Hundreds of varieties and strains have been grown at different places, studied, compared, described, and specimens assembled in the herbarium in a classified order. The herbarium now contains over 10,000 specimens. About 5,500 additional separate sowings were made in the fall of 1917 and spring of 1918.

Numerous selections for further trial and comparison at several stations were made from progenies of the large number of wheat hybrids previously effected. Inheritance studies in hybrids and pure lines were continued.

*Assignment.*—C. E. Leighty, leader, eastern wheat investigations; J. Allen Clark, leader, western wheat investigations.

*Proposed expenditures, 1918-19.*—\$35,602.

### Oat Investigations:

*Object.*—The improvement of oats by a study of production methods, the breeding of new varieties, and the extension of the winter-oat area.

*Procedure.*—Extensive varietal tests are being conducted. New varieties and selections are being produced by the pure-line method from the better commercial varieties and from hybrids. The pure-line selections include strains specially suited for growing under irrigation. A study of cultivated varieties and of closely allied species is in progress, with a view to the classification and description of American varieties of oats. Experiments in production methods are conducted, as well as studies of the methods employed by the best farmers in different sections of the country.

*Cooperation.*—State experiment stations in Georgia, Idaho, Iowa, Kansas, Montana, Nebraska, New York (Cornell), North Carolina, North Dakota, Oregon, South Dakota, Utah, and Washington, and the Wyoming State Board of Farm Commissioners.

*Location.*—Chico, Cal., Akron, Colo., Athens, Douglas, and Tifton, Ga., Aberdeen, Idaho, Ames, Iowa, Hays and Manhattan, Kans., Havre and Moccasin, Mont., Lincoln, Nebr., Ithaca, N. Y., Raleigh, Statesville, and Swannanoa, N. C., Dickinson, Mandan, and Williston, N. Dak., Burns and Moro, Oreg., Brookings, Cottonwood, Highmore, and Newell, S. Dak., Amarillo, Tex., Nephi, Utah, Arlington Farm, Va., Lind, Wash., and Archer and Sheridan, Wyo.

*Date begun.*—1902.

*Results.*—Data given in Farmers' Bulletins 395, 420, 424, 436, 738, 749, 769, 786, 800, 878, 883, and 892; Bureau of Plant Industry Bulletins 182, 240, and 283; Bureau of Plant Industry Circulars 12, 30, 59, and 61; and Department Bulletins 30, 33, 39, 99, 270, 297, 336, 398, 402, 430, and 498.

New varieties of spring oats have been distributed through the Cornell University, Iowa, and other experiment stations, and selected stocks of winter oats from the Arlington Farm. The distribution of varieties suitable for irrigated land has been begun from the Aberdeen (Idaho) substation. The best varieties for numerous sections have been determined by varietal tests, and the results have been published or are in preparation for publication. Several hundred varieties have been grown and described in the classification nursery.



Richland, one of the selections of the Kherson oat, developed in co-operation with the Iowa station, is now grown on a large acreage in that State and to a less extent in other States. As this selection yields about 4 bushels to the acre more than the unselected Kherson, the estimated increase in production by the use of this selection is now at least 2,000,000 bushels annually. Similarly, a selection from the Welcome oat distributed from the Cornell station is now widely grown in New York. A high-yielding, very heavy, awnless winter oat selection has been distributed to a limited extent in Mississippi and Louisiana. The following bulletins presenting data on oat investigations have been published during the year: Farmers' Bulletins 878, 883, and 892, and Department Bulletin 498.

*Assignment.*—C. W. Warburton, T. R. Stanton.

*Proposed expenditures, 1918-19.*—\$15,908.

### Barley Investigations:

*Object.*—Production of new varieties by breeding and incidental inheritance studies upon the crosses made; study of the physiology and morphology of the barley grain; study of production methods; extension of the barley-growing areas by the use of new varieties, new importations, and the better utilization of those already at hand; and the agronomic classification of barley varieties.

*Procedure.*—Extensive breeding experiments are being carried on for the purpose of producing superior varieties. The products of the principal breeding nurseries—those at Arlington Farm, Va., St. Paul, Minn., Aberdeen, Idaho, and Chico, Cal.—are annually distributed to the areas where they are best suited. Morphological and physiological studies of the grain and plant are being carried out, in order to interpret environmental and cultural effects. The study of the cause of high nitrogen in the barleys of the dry lands is being continued, and it is expected to correlate this behavior with the development of grain under irrigated conditions. The study of production methods is being carried on in certain areas in continuous experiments. Efforts are being made to discover more hardy winter barleys, more drought-resistant summer forms, and more productive types of all kinds. Data are being accumulated upon which to base a classification of the agricultural varieties of barley. This study has for its ultimate object the identification and description of all varieties which have been or are in cultivation in America. By this means it is hoped to interpret work which has not realized its full value because of misnamed or unidentified varieties.

*Cooperation.*—State experiment stations in Georgia, Idaho, Kansas, Minnesota, Montana, New York, North Carolina, North Dakota, Oregon, South Dakota, and Washington; Amarillo (Tex.) Board of City Development and Wyoming Board of Farm Commissioners.

*Location.*—Chico, Cal., Akron, Colo., Athens, Ga., Aberdeen, Idaho, Hays, Kans., St. Paul, Minn., Moccasin, Mont., Ithaca, N. Y., Raleigh, N. C., Dickinson and Williston, N. Dak., Burns and Moro, Oreg., Brookings, Cottonwood, Highmore, and Newell, S. Dak., Amarillo, Tex., Nephi, Utah, Arlington Farm, Va., Lind, Wash., and Archer, Wyo.

*Date begun.*—1902.

*Results.*—The results of the studies made in barley investigations have been published from time to time in B. P. I. Circulars 5, 61, and 62; B. P. I. Bulletins 240 and 283; Department Bulletins 30, 33, 39, 137, 183, 270, 297, 336, 398, 402, 430, 498, and 622; and Farmers' Bulletins 427, 443, 518, 749, 800, 878, and 883. The Bureau of Plant Industry and Department Bulletins give the data from experiments at various field stations, consisting largely of yields of varieties and the results of cropping methods. Morphological and physiological studies of grain and plant have already shown why awnless barleys are not suited to humid districts. In some instances purely technical studies, as of the malting function of this barley grain, inheritance studies of the breeding nursery, or classification of botanical varieties, are reported. The Farmers' Bulletins are concerned with general recommendations as to the best methods of growing barley.

*Assignment.*—H. V. Harlan.

*Proposed expenditures, 1918-19.*—\$12,673.



**Rice Investigations:**

*Object.*—The improvement of rice by a study of the cultural requirements and varietal adaptations and by selection and breeding.

*Procedure.*—Rices from foreign countries are introduced and tested for earliness of maturity, quality, and yielding power. From the promising varieties individual plants of the most desirable types are selected. In this way superior types are developed and increased for distribution. Cultural tests are made to determine how yield may be affected by different depths of plowing, different methods of preparing the seed bed, and different rates, depths, and dates of seeding. Various commercial fertilizers are used at different rates to determine their effect on yield. The water requirements of the crop are determined by the application of irrigation water at different depths and dates of submergence, noting the effect of stagnant water as compared with slowly changing water and no irrigation. The control of weeds is attempted largely through rotations containing cultivated crops. The nursery is used for botanical and hybridization studies.

*Cooperation.*—Louisiana Experiment Station and Sacramento Valley Grain Association of California.

*Location.*—Crowley, La., and Biggs, Cal.

*Date begun.*—1905.

*Results.*—New varieties have been distributed for commercial plantings; hybrids have been produced that are resistant to the fungous disease *Piricularia oryzae*, commonly known as “rotten neck”; and control of red rice by rotations containing cultivated crops has been demonstrated. Valuable data on the water requirements of the rice crop have been obtained, and the cooking quality of new strains and varieties that have been developed have been determined. The investigations of rice in the Sacramento Valley of California are reported in Bureau of Plant Industry Circular 97. The rice industry in California has been established largely on the basis of these investigations. Farmers’ Bulletin 688 deals with the culture of rice in California. A full discussion of the rice industry is given in Circular 89, Office of the Secretary.

*Assignment.*—Charles E. Chambliss, J. Mitchell Jenkins, J. W. Jones.

*Proposed expenditures, 1918-19.*—\$11,910.

(See also Supplement—Emergency Activities, p. 559.)

**Grain-Sorghum and Broom-Corn Investigations:**

*Object.*—To improve varieties by breeding, determine varietal adaptation, study cultural requirements, extend the producing area, determine the human-food value of sorghum meal, and promote the commercial uses of these crops.

*Procedure.*—Extensive plat experiments are conducted to determine varietal adaptation and yielding power of domestic and foreign varieties. Pure-line selections of promising varieties are made, compared, and developed if satisfactory. Experiments are made in seeding at different dates, at different rates per acre, and by different methods of spacing to determine the effect on quantity and quality of the resulting crop. The above experiments apply both to grain sorghums and broom corn. With broom corn, additional experiments are conducted to determine the effects of harvesting the brush at different stages of development and of curing it by different methods, with special references to color, weight, and durability of brush.

*Cooperation.*—Experiment stations of Kansas and South Dakota and to a minor extent of other Western States, and the Amarillo (Tex.) Board of City Development.

*Location.*—Chico, Cal., Akron, Colo., Hays and Garden City, Kans., Woodward and Lawton, Okla., Moro, Oreg., Highmore and Newell, S. Dak., Amarillo, San Antonio, and Big Springs, Tex., Tucumcari, N. Mex., and Arlington Farm, Va.

*Date begun.*—Grain sorghums, 1905; broom corn, 1911.

*Results.*—Data published in Bureau of Plant Industry Circulars 50 and 122; B. P. I. Bulletins 175, 203, 237, 253, and 283; Farmers’ Bulletins 322, 448, 552, 686, 768, 827, 958, and 972; Department Yearbook Separate 625; Department Bulletin 698, entitled “Grain Sorghum Experiments in the Panhandle of Texas,” presenting the results of nine years of plant experiments at Amarillo, Tex., now in press.



All varieties produce well in favorable seasons. In less favorable seasons production is in proportion to varietal adaptation. Only well-adapted varieties are able to produce in poor seasons. About three-fourths of the seasons are either unfavorable or poor, which makes varietal adaptation important.

Earliness is the most important single factor in varietal adaptation of these crops. Dwarfness is the next important factor in this regard. The combination of these two factors is extremely efficient in insuring adaptation to environmental conditions, which include frequent droughty periods. Dwarf milo, Dawn (dwarf) kafir, and Sunrise (early) kafir are shown to be well-adapted varieties. The time, effort, and money spent in breeding these dwarf and early varieties are fully justified by their value. The acreage devoted to them is being rapidly increased.

Grain sorghums are grown ordinarily in rows spaced  $3\frac{1}{2}$  feet apart. Experiments are made to determine the effect on yield of spacing them 7 feet apart, with two rates of seeding. One gives the same number of plants to the row, and the other the same number to the acre, or twice the number to the row. In dry or unfavorable seasons the yield and quality of grain are highest in the widely spaced rows having twice as many plants to the row. In favorable seasons the ordinary spacing gives best results.

*Assignment.*—B. E. Rothgeb, J. B. Sieglinger.

*Proposed expenditures, 1918-19.*—\$6,860.

(See also Supplement—Emergency Activities, p. 558.)

### Investigations of Minor Cereals:

*Object.*—The improvement of rye, proso, and buckwheat in yield and quality by means of breeding and the study of cultural methods.

*Procedure.*—Varietal tests and breeding operations are under way, and a study is being made of the field requirements of the crops. Studies of rye pollination are being conducted.

*Cooperation.*—State experiment stations of Georgia, Idaho, Iowa, Kansas, Missouri, Montana, New York (Cornell), North Carolina, North Dakota, Oregon, South Dakota, Tennessee, Utah, and Washington; Amarillo (Tex.) Board of City Development, and Wyoming Board of Farm Commissioners.

*Location.*—Chico, Cal., Akron, Colo., Athens, Quitman, and Tifton, Ga., Aberdeen, Idaho, Ames, Iowa, Hays and Manhattan, Kans., Columbia, Mo., Moccasin, Mont., Ithaca, N. Y., Statesville, Swannanoa, and West Raleigh, N. C., Dickinson and Williston, N. Dak., Burns and Moro, Oreg., Highmore and Newell, S. Dak., Knoxville, Tenn., Amarillo, Tex., Arlington Farm, Va., Nephi, Utah, Lind, Wash., and Archer, Wyo.

*Date begun.*—Proso, 1898; buckwheat, 1908; rye, 1911.

*Results.*—Results have been obtained showing the dependence of rye on pollen from other rye plants in fertilization. Natural wheat-rye hybrids have been discovered and descriptions of such hybrids published. Farmers' Bulletin 756 discusses the culture of rye in the eastern half of the United States, and Farmers' Bulletin 894 discusses rye growing in the Southeastern States. Very large increases in the rye acreage have occurred in the past few years, especially in 1917.

The best varieties of introduced proso have been determined, these being as follows in the order of their value: Black Voronezh, Tambov, Red Lump, Orenburg Red, and Turghai.

*Assignment.*—C. R. Ball, C. E. Leighty, J. Allen Clark.

*Proposed expenditures, 1918-19.*—\$1,832.

### Flax Investigations:

*Object.*—Improvement of flax through selection and breeding; introduction and acclimatization of foreign varieties and study of their adaptation to different sections; extension of the flax acreage in the Northwest and development of a winter-flax area in the Southwest; determination of the best cultural and production methods; the obtaining of a knowledge of inheritance in hybrids; and the botanical and agronomic classification of flax varieties.

*Procedure.*—New introductions and selections from field plats and from the hybrid breeding nurseries are compared in single and replicated nursery rows. Promising strains are increased to field plats and the best yielding among them distributed for nursery and field-plat experiments



at other stations and increased for distribution to farmers. The principal nursery experiments and breeding investigations are carried on at Mandan and Fargo, N. Dak., from which points distribution is made. Cultural investigations, including the effect of varying dates, rates, and methods of seeding, also are conducted. Acclimatization studies and the introduction of varieties into new areas, such as the irrigated valleys of the Southwest, and the reintroduction of the crop into older agricultural areas are under way. Breeding investigations which have as their main object the production of new strains combining desirable characters found in varieties not adapted to our conditions offer opportunities for the study of inheritance in flax. This study and the classification of pure lines offer, also, excellent material for a study of botanical and agronomic classification. War emergencies have developed special needs, and much time has been given to assisting the Department Seed Stocks Committee in locating available supplies of seed flax and in the distribution of same. This has necessitated some reduction in the amount of investigational work being undertaken.

*Cooperation.*—Experiment stations in Idaho, Minnesota, Montana, New York (Cornell), North Dakota, Oregon, and South Dakota, and Wyoming Board of Farm Commissioners.

*Location.*—Tempe and Sacaton, Ariz., Bard, Chula Vista, and Davis, Cal., Aberdeen, Idaho, St. Paul, Minn., Havre, Bozeman, and Moccasin, Mont., Dickinson, Fargo, Mandan, and Williston, N. Dak., Ithaca, N. Y., Burns and Corvallis, Oreg., Brookings, Highmore, Eureka, Cottonwood, and Howell, S. Dak., San Antonio, Tex., and Archer, Wyo.; minor experiments and nursery series at Chico and Biggs, Cal., Crowley, La., Moro, Oreg., and Lind, Wash.

*Date begun.*—1913.

*Results.*—General information on varieties and cultural methods is given in Farmers Bulletin 785, "Seed Flax Production." Material is in hand for scientific papers and bulletins giving different phases of agronomic and chemical studies on varieties covering a 5-year period. Data on 15 varieties on breaking tested at one station for three consecutive years, together with results from a nursery series containing a larger range of varieties, and from date and rate-of-seeding experiments, have been compiled for publication. Information has been furnished during the year to the Council of National Defense, the War Trades Board, and the Shipping Board.

Investigational work was continued at all stations. From the 3,000 head rows of first, second, third, and fourth generation hybrids at Mandan, N. Dak., many promising lines coming true to type were selected for increase and further study, while individuals in segregating rows were selected for the study of special characters. A new series of hybrids was made, including many new types. Drought and hail affected adversely tests at many of the northern stations, while severe weather conditions during the winter of 1916-17 damaged the plantings at some stations in the Southwest. At others results were secured of greater promise than had yet been obtained. In this area many problems concerning flax as a winter crop in the irrigated valleys need intensive study. Cooperative work in New York conducted through the county agents was interrupted because of the demands upon their time for emergency war work.

A campaign for increased flax acreage in 1917 was conducted in the spring of that year. In addition to urging through the press the necessity for increasing flax acreage, bankers, business men, and elevator companies were urged to assist in every way possible to obtain adequate seed supplies for seeding requirements. Seed surveys which located both available seed and seed shortages were made, and persons in need of seed were directed to their nearest supplies.

Although an increase in acreage of more than 20 per cent was secured in 1917, the severe drought that extended over the main flax-producing area resulted in the smallest crop in many years. From a commercial as well as scientific point of view, the 1917 crop year was an unfavorable one for flax.

*Assignment.*—C. H. Clark, J. C. Brinamade, jr., Theodore Stoa.

*Proposed expenditures, 1918-19.*—\$4,860.

**Total, Production and Improvement of Cereals, Flax, and Broom Corn and Their Products, \$89,645, including \$3,200 statutory.**

(See also Supplement—Emergency Activities, p. 558.)



## CEREAL AND FLAX TILLAGE ROTATION INVESTIGATIONS.

**Cereal and Flax Tillage and Rotation Investigations:**

*Object.*—To improve the yield and quality of cereals and flaxseed through better cultural methods and rotations; to reduce the necessity for frequent summer fallowing on certain dry lands of the West; to increase the humus content of the soil through rotations with tilled crops and by green manuring; and to determine the place of flax in crop rotation with reference to diseases and weeds.

*Procedure.*—Experiments are conducted to determine the effect of different methods of seed-bed preparation on the resulting crop. Series of rotations have been established containing different leguminous crops, especially field peas and alfalfa, to determine the fertilizing and humus-making value of these crops in rotation with cereals. Rotation series containing tilled crops such as peas, potatoes, alfalfa, corn, sorghum, etc., are established to determine whether these crops can be used in place of the summer fallow now considered necessary for conservation of moisture. Rotations containing flax are located at four stations in North Dakota.

*Cooperation.*—State experiment stations of Georgia, Idaho, North Dakota, Oregon, Utah, and Washington.

*Location.*—Athens, Ga., Aberdeen, Idaho, Fargo, Hettinger, Langdon, Mandan, and Williston, N. Dak., Burns and Moro, Oreg., Nephi, Utah, and Lind, Wash.

*Date begun.*—1904.

*Results.*—Department Bulletin 157 contains the results of tillage and rotation experiments conducted at the Nephi substation in Utah during the years 1908 to 1913, inclusive. Tillage experiments in Oregon show that plowing stubble land for fallow on April 1, May 1, and June 1 has given striking results in favor of the earliest date. The average increase in acre yield resulting from early plowing has been more than 7 bushels. Late plowing has been the ordinary farm practice in this district, and the experimental proof that early plowing materially increases yields is of enormous value to the farmers and to the cause of wheat production. Rotation experiments have shown that in certain districts field peas and potatoes may be used to replace fallow and will give profitable returns in themselves while at the same time not reducing yields of the cereal crops following them. Good effects have followed the plowing under of green rye or vetch, or both, as green manure in humid districts.

*Assignment.*—C. R. Ball, L. C. Aicher, A. F. Bracken, M. A. McCall, J. H. Martin, D. E. Stephens, T. E. Stoa.

*Proposed expenditures, 1918-19.*—\$2,700.

## CEREAL-DISEASE INVESTIGATIONS.

**Investigations of Cereal Rusts:**

*Object.*—(1) Stem (black) rust: To study the rust resistance of cereals, and of wheat and oats in particular; conduct cereal breeding experiments for the purpose of producing rust-resistant varieties; conduct laboratory and greenhouse studies on the physiology and morphology of stem rusts; obtain data on distribution and epidemiology; and determine the facts concerning the biologic forms of stem rust.

(2) Barberry eradication: To give wide publicity to the relation between the common barberry and the stem rust of wheat, oats, barley, rye, and grasses; to locate the barberry bushes and encourage their removal and destruction; determine the degree to which the barberry bushes rust; and to ascertain the relation between the rust on these bushes and stem-rust attacks on cereals in the general region.

(3) Stripe rust: To study the geographic distribution, epidemiology, and wild-grass forms of stripe rust; determine the relation of rust-infected seed to subsequent development of rust in plants grown from such seed; make a thorough study of the relation of climatic factors to distribution and epidemiology; and conduct experiments in breeding and selection for rust resistance.

(4) Leaf rusts: To conduct a thorough study of the distribution, physiology, morphology, epidemiology, and biologic forms of the crown rust of oats and the leaf rusts of wheat, barley, and rye.



*Procedure*—(1) Stem (black) rust: Greenhouse and nursery cultures of a number of varieties of wheat and other small grains are conducted to determine the relative resistance of each and the relation of growth factors to infection. Extensive hybridization and selection experiments are conducted in the field nursery at St. Paul, Minn. Rust-resistant durum wheats and other resistant varieties are crossed on varieties noted chiefly for milling and bread-making qualities to obtain good all-purpose and rust-resistant strains. The physiology and chemistry of infection are studied to obtain more data on the physiological behavior of host plants and of host tissues when subject to invasion by the rust organism. More precise knowledge of the relation of growth factors will be obtained through the use of the more refined methods of recording relative humidity, evaporation, soil and atmospheric temperatures, wind movement, etc. These investigations have been greatly increased and the following additional work has been undertaken: An exhaustive study of the rust-in-seed problem; extensive field observations and studies in North Dakota, South Dakota, Minnesota, Kansas, and wheat-producing sections elsewhere in the United States; a continuation of studies on the relationships of the rusts of grasses to cereal crops, and vice versa; and further studies on the cytology of infection.

(2) Barberry eradication: Field assistants, working in cooperation with State leaders in the various States and through the States Relations Service and other available agencies, give the information verbally, by circular letters, circulars, posters, newspaper articles, and all other available means, to farmers, townspeople, nurserymen, landscapers, park boards, schools, boys' and girls' clubs, boy scouts, State and county councils of defense, and other available agencies. They will also make a survey to determine the distribution of the rust-bearing varieties of barberry and the amount of rust on these bushes and on nearby grains and grasses. This information is taken on uniform blanks and sent to the State leaders and also to the leader in charge of all the work.

(3) Stripe rust: Field, greenhouse, and laboratory experiments are under way to determine the following: Relation of wild-grass forms of this rust to wheat, barley, and rye; relation of infected seed to subsequent outbreak of rust; varietal (host) susceptibility, over-wintering, summer desiccation, and relation of meteorologic factors to rust development.

(4) Leaf rusts: In cooperation with the Iowa Agricultural Experiment Station, an exhaustive study of crown rust of oats is in progress. The work is being conducted with a view to determine facts concerning varietal susceptibility to crown rust, physiology of infection, biologic forms, over-wintering, ecology, and rust resistance. The study of the leaf rusts of wheat, barley, rye, and maize is about to be undertaken.

*Cooperation*.—(1) Stem (black) rust: Experiment stations of Minnesota, Kansas, and Tennessee. (2) Barberry eradication: Agricultural experiment stations in Colorado, Illinois, Iowa, Indiana, Michigan, Minnesota, Montana, Nebraska, Ohio, South Dakota, Wisconsin, and Wyoming. (3) Stripe rust: Oregon Experiment Station. (4) Leaf rust: Purdue University Agricultural Experiment Station.

*Location*.—(1) Washington, D. C., St. Paul, Minn., Manhattan, Kans., and Jackson, Tenn.; (2) Washington, D. C., Fort Collins, Colo., Champaign-Urbana, Ill., Ames, Iowa, LaFayette, Ind., East Lansing, Mich., St. Paul, Minn., Bozeman, Mont., Lincoln, Nebr., Wooster and Columbus, Ohio, Brookings, S. Dak., Madison, Wis., and Laramie, Wyo.; (3) Corvallis, Oreg.; (4) LaFayette, Ind.

*Date begun*.—(1) Stem rust, 1894; (2) barberry eradication, 1917; (3) stripe rust, 1915; (4) leaf rusts, 1915.

*Results*.—(1) Stem rust: Data published in Vegetable Pathology and Physiology Bulletin 16, Bureau of Plant Industry Bulletins 63, 216, and 224, and Farmers' Bulletin 629; additional data secured on the question of rust-resistant varieties now in manuscript and about to be submitted for publication as a Department Bulletin. Considerable work has been done relative to the influence of meteorological factors on the development of rust epidemics. Extensive milling and baking tests have been made with reference to a number of rust-resistant hybrids.



(2) Barberry eradication: Public sentiment in the States named has been aroused; nurserymen for the most part have agreed to discontinue distributing common barberry bushes; information has been widely disseminated to schools and the general public. The park boards in many of the large cities have decided to eradicate the common barberry. The State nursery inspectors or State entomologists have declared their intention of destroying common barberry bushes wherever found infected within their respective States. Several State councils of defense have issued appeals for the eradication of the common barberry. As a result of the campaign, the Public Safety Commission of Minnesota has issued an order providing for the compulsory eradication of common barberry from the State. A law providing for barberry eradication has been on the statute books of North Dakota for over a year.

(3) Stripe rust: In May, 1915, the stripe rust (*Puccinia glumarum*) was observed to occur in several of the Pacific and Intermountain States. It has since been shown that this rust has been present in the United States at least since 1892. A bulletin concerning it is now in preparation.

*Assignment.*—H. B. Humphrey, E. C. Stakman, C. W. Hungerford.

*Proposed expenditures, 1918-19.*—\$254,300.

### **Investigations of the Fungous and Nonparasitic Diseases of Corn, Sorghum, and Broom Corn, Except Rusts and Smuts:**

*Object.*—To investigate the life histories and physiology of the fungi affecting corn, sorghum, and broom corn, devise methods of control, and secure information relative to the geographic distribution and economic importance of these diseases; to prevent, if possible, the introduction of downy mildews of corn into this country and to be prepared to combat them in the event of their appearance.

*Procedure.*—Field, laboratory, and greenhouse experiments are now in progress and others are carried on to determine unknown facts concerning the life histories and physiological behavior of hosts to parasites, and vice versa. Work on the Physoderma disease of corn is under way. The entire time of one man is devoted to its investigation. A cooperative field survey conducted throughout the corn belt showed the Physoderma disease of corn present in 27 States but of economic significance only in the Gulf and South Atlantic Coast States. Life-history studies are well advanced. The downy mildews of corn and related crops in the Orient are being studied with reference to their distribution, hosts, taxonomic relationships, and economic importance. Considerable progress has been made in the study of root and ear rots of corn; the pathogenicity of several organisms is being tested; field, laboratory, and greenhouse studies are under way; and the wheat-scab organism is being studied with reference to corn root-rot.

*Cooperation.*—Minnesota, Kansas, Indiana, Georgia, Tennessee, Iowa, Nebraska, and Wisconsin experiment stations.

*Location.*—Washington, D. C., Manhattan, Kans., LaFayette, Ind., Athens, Ga., Jackson, Tenn., Ames, Iowa, Lincoln, Nebr., St. Paul, Minn., and Amarillo, Tex.

*Date begun.*—1906.

*Results.*—Progress has been made in the determination of the life history of the fungus causing the Physoderma disease of corn, and its distribution has been found to be general throughout the Southern States. A Fusarium disease of corn is found to be quite serious in Illinois and Iowa and other parts of the corn belt. Work in the study of foreign corn mildews is being undertaken.

*Assignment.*—H. B. Humphrey, W. H. Weston, W. H. Tisdale.

*Proposed expenditures, 1918-19.*—\$33,300.

### **Investigations of the Cereal Smuts:**

*Object.*—To investigate the physiology and distribution of the cereal smuts, determine incompletely known facts pertaining to their life histories, and improve present methods of smut control and devise new ones.

*Procedure.*—Bunt or stinking smut: The small field and nursery experiments which have been in progress since 1913 will now be supplemented by similar experiments on a much larger scale involving the use of



acreage in several parts of Oregon, in order to determine the necessary length of rotation period for prevention of bunt in the Pacific Northwest. Further laboratory and field experiments will be conducted to determine accurately the influence of soil moisture and soil temperature on the infection of wheat by the bunt organism, to determine the relation of early and late sowing on infection, to ascertain facts concerning the relation of tillage to infection, and to study by chemical analysis the chemistry of infection. Field and nursery experiments will be conducted at Moro, Oreg., to determine the best methods of seed treatment of wheat grown in the semiarid districts of the United States.

**Loose smuts of wheat and barley:** There is now being made a careful experimental study of the process of infection, in order that better control of infection may be had in the artificial inoculation of material for microscopic study and that work on the subject of control measures may be facilitated through seed selection. An automatic control of the hot-water treatment at 42–50° C. is now being perfected in an effort to make it of practical value. Other methods of prevention are also being studied.

**Oat smuts:** These are being studied with a view to a better understanding of their distinctions in field and artificial cultures and in their life-history characteristics. The application of these results to a critical study of the immunity of Burt oats is projected.

*Cooperation.*—State experiment stations of Kansas, Minnesota, and Oregon.

*Location.*—Washington, D. C., Manhattan, Kans., St. Paul, Minn., Corvallis, Oreg., Madison, Wis., and field stations of the Office of Cereal Investigations.

*Date begun.*—1890.

*Results.*—Methods of prevention of bunt or stinking smut of wheat, covered smut of barley, and oat smut worked out; estimated annual preventable loss 100,000,000 bushels; data in Bureau of Plant Industry Bulletin 152, Department Bulletin 30, and Farmers' Bulletins 219 and 507. Loose smut of rye was discovered in 1913. Stem smut of rye has been found serious in the North-Central States, and it has been shown to be preventable by seed treatment. Additional data have been recorded on the influence of soil temperature and soil moisture on the infection of wheat by the stinking-smut organism, on crop rotation as a means of controlling stinking smut in the Pacific Northwest, and on the relation of wind-disseminated spores to the occurrence of bunt in regions where the biennial cropping system is followed.

An indicator for the automatic control of the treatment at 40–50° C. has been perfected to a point of considerable experimental value. It has been shown that the formaldehyde treatment gives a partial control of loose smut in barley but that it is not dependable.

The specific distinction between the two smuts of oats has been confirmed. The immunity of Burt oats has been called in question by the past season's results.

Kernel smut of sorghum has been found to be preventable; data in B. P. I. Circular 8. The life history of head smut of sorghum has been made known and the results published in the Journal of Agricultural Research, vol. 2, No. 5, under the title "Head Smut of Sorghum and Maize"; also a paper in Phytopathology, vol. 5, No. 3, under the title "Loose Kernel Smut of Sorghum." Farmers' Bulletin 939, entitled "Cereal Smuts and the Disinfection of Seed," has been issued recently.

The corn-smut organism has been found to occur on the young plants and in the air before the disease appears in the field. Spraying has reduced the amount of smut, but this is probably because it also reduced the amount of growth in the plants by the injury it caused. Efforts to avoid this injury are being made.

Varieties of grain sorghum (milo and feterita) said to be immune from kernel smut have been found to be only highly resistant, which explains the failure to get immune hybrids. Other highly resistant sorts have been found.

*Probable date of completion.*—1925.

*Assignment.*—H. B. Humphrey, A. A. Potter.

*Proposed expenditures, 1918–19.*—\$7,740.

(See also Supplement—Emergency Activities, p. 554.)



**Miscellaneous Cereal and Flax Diseases:**

*Object.*—To determine the prevalence and economic importance of the disease-producing fungi common to rice and the other minor cereal crops and of flax, and to investigate their life histories and methods for their control; to investigate the imperfect fungi known to cause diseases of economic importance in cereals and to devise methods of control.

*Procedure.*—Diseases of rice: Carefully conducted field, greenhouse, and laboratory experiments relating to the physiology, life history, and control of the rice-blast organism, *Piricularia grisea*, and several other organisms which are related to seedling blights, leaf diseases, and possibly to straight-head, are made. Comprehensive experiments on the relation of cultural treatments to the probable causes of straight-head are under way.

Diseases of barley: Cooperation will be continued with the Wisconsin Experiment Station on the Helminthosporium diseases of barley. Studies covering the life histories and habits of the several organisms, cardinal temperatures, physiology of infection, methods of control by means of formaldehyde and other fungicides, distribution and economic importance of each of the three diseases, and the relation of the causative organisms to other cereals and to wild and cultivated grasses are under way.

Field and laboratory studies are being conducted to determine the cause of flax canker and to determine facts relative to the physiology and etiology of flax wilt.

*Cooperation.*—State experiment stations of North Dakota and Wisconsin.

*Location.*—Washington, D. C., Fargo, N. Dak., Madison, Wis., and field stations of the Office of Cereal Investigations.

*Date begun.*—1904.

*Results.*—Rice: Two species of *Fusarium* found with considerable constancy in diseased rice plants have been isolated and studied and further data on the physiology of *Piricularia grisea* accumulated. The relation of different organisms to seedling blights has been established. The organism causing a very common leaf disease has been isolated, and studies in its life history are being made. Considerable data bearing upon the apparent influence of cultural treatments on straight-head have been accumulated and utilized in experimental work.

Other cereals: Experimental evidence showing the susceptibility of wheat and oats to infection has been obtained, and species of *Helminthosporium* and *Fusarium* have been isolated from diseased plants received from different parts of the country. A paper entitled "A Study of Some Imperfect Fungi Isolated from Wheat, Oats, and Barley Plants," was published in the *Journal of Agricultural Research*, vol. 1, No. 6. Stripe disease of barley is found to be largely preventable by formaldehyde treatment.

*Assignment.*—H. B. Humphrey, C. S. Reddy, R. D. Rands.

*Proposed expenditures, 1918-19.*—\$7,560.

**Total, Cereal-Disease Investigations, \$302,900, including \$1,200 statutory.**

**Total, Cereal Investigations, \$410,745, including \$9,240 statutory.**

[Research.]

**CORN INVESTIGATIONS.****Supervision:**

*Object.*—To supervise the various subactivities under this group and carry on routine office business in connection with corn investigations, including correspondence, maintenance of records, purchase of supplies and equipment, etc.

*Location.*—Washington, D. C.

*Date begun.*—1900.

*Assignment.*—C. P. Hartley, E. B. Brown, J. M. Hammerly.

*Proposed expenditures, 1918-19.*—\$9,700.

**Production of Improved Strains of Corn for the Different Geographical Sections of the United States:**

*Object.*—To determine by investigational work efficient methods of corn breeding and their practical application in the improvement of strains of corn under different environments.



*Procedure.*—Methods of breeding corn are tested with many strains under different environments and accurate data as to results obtained. Improved seed is placed with farmers throughout the United States and suggestions given as to corn improvement.

*Cooperation.*—Individual farmers.

*Location.*—Arlington Farm, Occoquan, and Round Hill, Va.; Oconomowoc, Wis.; Piketon and Waverly, Ohio; Rhinebeck and Walton, N. Y.; Darlington, S. C.; Marshall and Waco, Tex.; Beatrice, Nebr.; Charleston and St. Charles, Mo.; Armorer, Ark.; Thomasville, Ga.; Clarksdale, Miss.; Harwarden, Iowa; Larimore, N. Dak.; Huron, S. Dak.; Prattville and Gurley, Ala.

*Date begun.*—1900.

*Results.*—It has been demonstrated that certain methods of corn breeding can be practiced profitably but that variation of methods to suit different environments may be necessary. Several strains of corn of unusual productivity or otherwise of superior value have been originated and introduced. During the past fiscal year information was furnished to 30,000 correspondents, and 200 bushels of seed of new and improved varieties of corn were sent to 500 farmers in 47 States for testing in comparison with their best local varieties.

*Assignment.*—C. P. Hartley, E. B. Brown, C. H. Kyle, J. G. Willier, F. D. Richey, G. J. Burt, H. S. Garrison, C. D. Bennett, H. H. Biggar, H. Stoneberg, C. E. Trout.

*Proposed expenditures, 1918-19.*—\$11,000.

### **Corn Improvement with Reference to Corn Products:**

*Object.*—To develop types better suited to specific purposes in the manufacture of corn products; to determine methods of breeding, curing, and storage that will improve the popping qualities and wholesomeness of popcorn.

*Procedure.*—Comparative tests of the desired qualities are made, and isolated breeding plats planted from seed having these qualities most fully developed are maintained.

*Cooperation.*—Individual farmers, domestic-science schools, millers, and manufacturers.

*Location.*—Washington, D. C., Oconomowoc, Wis., and Piketon, Ohio.

*Date begun.*—1910.

*Results.*—Information is being accumulated upon the culinary properties and palatability of meal made from different types of corn and from the same type by different processes. Data upon popcorn are published in Farmers' Bulletins 553 and 554. It has been shown that the moisture content of popcorn influences the volume and quality of the popped corn.

*Assignment.*—C. P. Hartley, J. G. Willier.

*Proposed expenditures, 1918-19.*—\$2,000.

### **Study of Heredity and Environmental Effects:**

*Object.*—To investigate the effects of inheritance and environment upon the plant and to determine general laws governing them; to develop and improve methods of corn breeding based upon the results of these studies.

*Procedure.*—The same variety or strain is tested under different environments, and different varieties and strains are tested under same environments.

*Cooperation.*—Individual farmers.

*Location.*—Observations throughout the United States; experimental plats located in New York, Virginia, South Carolina, North Carolina, Georgia, Florida, Mississippi, Louisiana, Texas, Oklahoma, Arizona, Missouri, Michigan, Ohio, Arkansas, Wisconsin, North Dakota, South Dakota, Nebraska, Colorado, Nevada, Alabama, Maryland, Iowa, California, Washington, Wyoming, Minnesota, and Pennsylvania.

*Date begun.*—1901.

*Results.*—Data have been secured upon the degree and extent of inheritance of certain characters and upon the effects of self-fertilization, close breeding, broad breeding, and crossbreeding; results published in Bureau of Plant Industry Bulletin 218 and Farmers' Bulletin 915. The possibility of developing frost-resistant strains adapted to earlier planting and capable of better yields at lower temperatures than existing varieties has been established. Short-season and long-season varieties differ in



response to extraordinarily early planting in northern localities. The best grade of ensilage is obtained from long-season varieties planted very early.

*Assignment.*—C. P. Hartley, E. B. Brown, C. H. Kyle, J. G. Willier, F. D. Richey, G. J. Burt, H. S. Garrison, C. D. Bennett, H. H. Biggar, H. Stoneberg, C. E. Trout.

*Proposed expenditures, 1918-19.*—\$10,000.

### **Seed-Corn Selection, Fumigation, Drying, and Preservation:**

*Object.*—To develop and improve methods of seed-corn selection, fumigation, drying, and preservation.

*Procedure.*—Different methods of selection, fumigation, drying, and preservation are tested in different environments.

*Cooperation.*—Individual farmers.

*Location.*—Arlington Farm, Occoquan, and Round Hill, Va.; Oconomowoc, Wis.; Piketon and Waverly, Ohio; Rhinebeck and Walton, N. Y.; Darlington, S. C.; Clarksdale, Miss.; Marshall and Waco, Tex.; Beatrice, Nebr.; Charleston and St. Charles, Mo.; Amorel, Ark.; Oklahoma City, Okla.; Terra Ceia, N. C.; Thomasville, Ga.; Brooksville, Fla.; Hawarden, Iowa; Platte and Huron, S. Dak.; Larimore and Mandan, N. Dak.; and Montgomery and Massillon, Ala.

*Date begun.*—1901.

*Results.*—Valuable methods have been developed and are now in practice in many corn-growing sections; methods must be modified to meet different environmental conditions. Results published in *Farmers' Bulletins* 415 and 948.

*Assignment.*—C. P. Hartley, E. B. Brown, C. H. Kyle, J. G. Willier, F. D. Richey, G. J. Burt, H. S. Garrison, C. D. Bennett, H. H. Biggar, H. Stoneberg, C. E. Trout.

*Proposed expenditures, 1918-19.*—\$9,000.

### **Methods of Corn Culture:**

*Object.*—To improve and develop methods of corn culture; to determine fundamental principles that control stalk growth and grain production; to study the relation to stalk growth and grain production to the moisture content of the soil, the physical condition of the soil, methods of planting, cultivation, rotation, and fertilization.

*Procedure.*—Similar experimental tests are conducted in different environments.

*Cooperation.*—Individual farmers.

*Location.*—Observations throughout the United States; experimental plats located in New York, Virginia, South Carolina, Georgia, Mississippi, Texas, Arkansas, Missouri, Ohio, Wisconsin, North Dakota, South Dakota, Nebraska, Alabama, and Minnesota.

*Date begun.*—1901.

*Results.*—Data accumulated upon factors influencing stalk growth and grain production; methods of rotation, planting, cultivation, and fertilization developed for different environments.

*Assignment.*—C. P. Hartley, E. B. Brown, C. H. Kyle, J. G. Willier, F. D. Richey, G. J. Burt, H. S. Garrison, C. D. Bennett, H. H. Biggar, H. Stoneberg, C. E. Trout.

*Proposed expenditures, 1918-19.*—\$3,000.

**Total, Corn Investigations, \$44,700, including \$4,700 statutory.**

[Research.]

## **TOBACCO INVESTIGATIONS.**

### **Supervision:**

*Object.*—To provide for necessary administrative and clerical work, including correspondence, preparation of manuscripts and reports, and other details connected with the prosecution of the field and laboratory investigations.

*Location.*—Washington, D. C.

*Date begun.*—1909.

*Assignment.*—W. W. Garner.

*Proposed expenditures, 1918-19.*—\$7,510.

**New England Cigar-Wrapper Tobacco Investigations:**

*Object.*—To develop principles and methods of tobacco breeding; to devise improved methods of growing, curing, and handling cigar-wrapper tobacco; to study the relation of environment to the development of the tobacco plant; to ascertain the causes of and remedies for lack of productiveness of tobacco soils.

*Procedure.*—Native tobaccos were crossed with Cuban and Sumatra varieties, and the character and behavior of hybrids are being studied. The behavior of tobacco under different soil and climatic conditions and under different curing conditions is investigated. Observations are made on tobacco curing carried out in a centralized plant under controlled conditions. Field tests are conducted to determine the relations of methods of fertilizing and of parasites to the lack of productiveness of tobacco soils.

*Cooperation.*—Connecticut Experiment Station and Harvard University.

*Location.*—Suffield and Tariffville, Conn.

*Results.*—As a result of the extensive studies on tobacco curing which have been made, the growers have come to realize the importance of controlling the moisture and temperature conditions in the curing barn in order to avoid serious losses from decay of the leaf and to insure a product of better quality. Several bulletins on this subject have been published. In the breeding work the principles applicable to the improvement of tobacco have been extensively studied.

During the past year special attention has been given to "tobacco-sick" soils on which poor yields are obtained, causing serious losses to growers, especially under the artificial shade used for growing wrapper leaf. Selected strains of Cuban and of binder types grown on these soils have given encouraging results, indicating that the disease may be controlled by the growing of resistant varieties. It has been shown, also, that the systematic use of fertilizers of acid reaction will materially reduce the injury caused by the disease.

*Date begun.*—1903.

*Assignment.*—E. G. Beinhart, E. M. East.

*Proposed expenditures, 1918-19.*—\$3,000.

**Maryland Export Tobacco Investigations:**

*Object.*—To improve the crop by breeding and selection, determine the best use of fertilizers for tobacco, develop the best systems of rotation adapted to tobacco, and develop improved methods of growing, curing, and handling tobacco.

*Procedure.*—Pure strains of native tobacco varieties are developed by systematic selection, and new types are produced by crossing native and related foreign varieties, followed by careful selection. Plat tests are carried out to determine the proper kind and quantity of commercial fertilizers to obtain best results with tobacco. Field experiments are conducted with systems of crop rotation specially adapted to restoring the depleted humus supply of the tobacco soils.

*Cooperation.*—Maryland Experiment Station.

*Location.*—Upper Marlboro, Md.

*Date begun.*—1905.

*Results.*—The new Maryland Mammoth type of tobacco which was obtained by selection from a native variety has proved much superior to the old Maryland varieties and is especially valuable in that it yields a fine quality of leaf under more intensive methods and on stronger soils than can be used for the old native types. This tobacco will be very generally grown in Maryland as soon as an adequate supply of seed is available. The State Experiment Station has issued a bulletin describing this and other new types produced in the cooperative tobacco investigations.

It has been shown that the growing of soil-improving crops under proper conditions greatly improves the yield and quality of the tobacco. Data have been obtained on the proper choice and arrangement of crops for the tobacco rotation.

It has been discovered that there is a serious root disease of tobacco on many farms in southern Maryland to which all native varieties are susceptible. The disease causes a slow and very uneven growth of the plants, often resulting in a very late crop, of inferior quality. The disease is being investigated, and the native types of tobacco have been



crossed with certain foreign varieties which are resistant to the disease, with a view to introduce the property of resistance into the native tobaccos. A *Fusarium* wilt disease of tobacco also has been discovered in restricted localities.

*Assignment.*—D. E. Brown.

*Proposed expenditures, 1918-19.*—\$1,700.

#### **Burley Tobacco Investigations:**

*Object.*—To develop and test pure strains of standard Burley varieties, to produce types of Burley resistant to root-rot and other diseases, to determine fertilizer requirements and best systems of crop rotation for Burley tobacco, and to develop better cultural and curing methods.

*Procedure.*—The more important varieties of Burley tobacco are subjected to comparative tests as to yield and quality, and pure strains of the better varieties are developed by seed selection. Tests with fertilizers and systems of crop rotation for Burley tobacco are carried out on sets of field plats. Types of Burley resistant to root-rot are developed by breeding and selection.

*Cooperation.*—West Virginia Experiment Station.

*Location.*—Guyandotte, W. Va., and Lexington, Ky.

*Date began.*—Kentucky, 1906; West Virginia, 1913.

*Results.*—It has been discovered that the tendency of Burley tobacco soils to become "tobacco sick" after one or two crops of Burley have been grown is due to tobacco root-rot, a parasitic disease to which ordinary White Burley is the most susceptible of all known varieties. On the other hand, selections of Burley obtained in Canada have shown such high resistance to the disease that a normal yield has been obtained on infested soil on which ordinary Burley was a complete failure. It is believed that these resistant types can be developed into exceedingly valuable tobaccos for the Burley section of Kentucky and adjoining States. As a feature of the work on this disease, the steam sterilization of tobacco seed beds has been successfully introduced into the Burley section of Kentucky.

*Assignment.*—James Johnson, R. H. Milton, T. C. McIlvaine.

*Proposed expenditures, 1918-19.*—\$1,500.

#### **Western Fire-Cured Tobacco Investigations:**

*Object.*—To determine the fertilizer requirements and the best systems of crop rotation for this type of tobacco; to develop better cultural and curing methods for producing fire-cured tobacco.

*Procedure.*—In order to develop methods for increasing the yield and maintaining good quality for the dark fire-cured tobacco, field test plats are arranged to bring out the most profitable use of fertilizer when combined with closer planting of the tobacco. A number of different systems of crop rotation are being tried out, all of which include tobacco as the leading money crop and one or more soil-improving crops.

*Cooperation.*—Tennessee Experiment Station.

*Location.*—Clarksville, Tenn.

*Date begun.*—1912.

*Results.*—More intensive methods and a restricted acreage for tobacco and further diversification of crops seem to be required in these districts. Moderate applications of phosphoric acid and nitrogen have consistently given large increases in the yield and value of the tobacco crop. Considerable data have been obtained on the relative values of different forms of nitrogen and phosphoric acid for tobacco. With a reasonable supply of humus in the soil but little response has been obtained with tobacco from the use of potash in the fertilizer. The systematic rotation of crops, including the growing of soil-improving crops, is giving greatly increased yields of tobacco. Improved methods of handling tobacco seed beds are being developed.

*Assignment.*—R. H. Milton.

*Proposed expenditures, 1918-19.*—\$1,800.

#### **New York Binder and Filler Tobacco Investigations:**

*Object.*—To develop improved types of tobacco by seed selection, determine the most profitable use of fertilizers for the tobacco crop, and introduce systems of crop rotation adapted to the culture of binder and filler leaf.

*Procedure.*—Fertilizer tests with tobacco are conducted on a series of field



plats. In the crop-rotation experiments the comparative merits of several different systems of rotation for tobacco culture are tried out. Seed selection with the standard native varieties of tobacco is practiced with a view to obtain improved strains. Special attention is given to the fertilizer and crop-rotation tests.

*Cooperation.*—New York (Geneva) Experiment Station.

*Location.*—Baldwinsville and Big Flats, N. Y.

*Date begun.*—1907.

*Results.*—In the tests with various kinds and quantities of nitrogenous, phosphatic, and potash fertilizers which have been in progress for several years extensive data have been obtained on the fertilizer requirements for cigar-filler tobacco. Decided differences in yield have been obtained from the different fertilizer treatments. More recently tests were undertaken with a view to restore the productiveness of run-down tobacco soils through the use of alfalfa and other soil-improving crops.

*Assignment.*—G. W. Harris.

*Proposed expenditures, 1918-19.*—\$1,950.

### **Sun-Cured, Fire-Cured, and Flue-Cured Tobacco Investigations:**

#### **(a) SUN-CURED, FIRE-CURED, AND FLUE-CURED TOBACCO INVESTIGATIONS IN VIRGINIA—**

*Object.*—To determine more profitable methods of fertilizing the tobacco crop, develop systems of rotation adapted to tobacco culture, and improve present cultural methods.

*Procedure.*—Local stations are maintained in the three principal tobacco districts for carrying out experiments with fertilizers and cultural methods.

*Cooperation.*—Virginia Experiment Station.

*Location.*—Appomattox, Chatham, and Bowling Green, Va.

*Date begun.*—1907.

*Results.*—During the past year additional data were obtained regarding the fertilizer requirements of the tobacco crop for the three principal types of leaf produced in Virginia.

In the work of the past several years it has been found that under proper conditions liberal fertilizing of the tobacco crop gives profitable returns, particularly when suitable systems of crop rotation are followed. Liberal applications of easily available phosphates properly balanced with nitrogen and potash have given the best results. Several bulletins giving details of the experiments have been issued by the Virginia Experiment Station. Crimson clover has greatly increased the yield of tobacco in the sun-cured district.

*Assignment.*—E. H. Mathewson.

*Proposed expenditures, 1918-19.*—\$1,400.

#### **(b) FLUE-CURED TOBACCO INVESTIGATIONS IN NORTH CAROLINA—**

*Object.*—To develop better tobacco varieties for flue curing; to improve fertilizer, rotation, cultural, and curing methods; to devise methods for the control of Granville wilt and other diseases.

*Procedure.*—Field experiments are conducted on leased lands at Reidsville and Creedmoor, N. C., and long-term experiments on a permanent location owned by the State at Oxford. In the work on rotation special attention is given to the use of soil-improving crops not injurious to the quality of tobacco. Special barns are used in the curing work. The control of Granville wilt by rotation of crops is studied by means of field plats located on badly diseased soil.

*Cooperation.*—North Carolina Experiment Station.

*Location.*—Creedmoor, Oxford, and Reidsville, N. C.

*Date begun.*—1909.

*Results.*—In the "Old Belt" section four years' tests have shown decided increases in the net returns from the crop through harvesting by the method of picking the leaves as they ripen, instead of cutting the stalk as has been done by growers. The process of picking the leaves as they ripen, which prevents the loss of lower leaves on the plant, is being adopted by many farmers. A bulletin giving the results of these tests has been published. In connection with this method of harvesting it has also been shown that closer planting, higher topping, and somewhat heavier fertilizing of the tobacco give best results. Extensive tests cov-



ering a number of years have shown generally profitable returns from the use of potash on the lighter soils in quantities approximating those normally applied by growers, and even on a considerable proportion of the heavier soils potash has given good results. On some of the light soils characteristic symptoms of potash hunger, together with certain leaf-spot diseases, have developed when potash was omitted from the fertilizer. It has been found that recent widespread outbreaks of leaf-spot disease were largely governed as to distribution by a combination of weather conditions and soil fertility. It has been demonstrated that the Granville wilt, a very destructive disease of tobacco, can be controlled through crop rotation if a proper choice of crops is made. A bulletin on the control of the disease has been published. Improvements in methods of curing, resulting in the saving of 50 per cent of the fuel required, have been developed and made available to farmers through a popular bulletin on the subject.

*Assignment.*—E. H. Mathewson, E. G. Moss.

*Proposed expenditures, 1918-19.*—\$4,500.

(c) **FLUE-CURED TOBACCO INVESTIGATIONS IN SOUTH CAROLINA—**

*Object.*—To test and improve by selection standard varieties of tobacco, and to determine the best methods of fertilizing and culture.

*Procedure.*—Plat experiments with fertilizers, systems of rotation adapted to tobacco, and improved cultural methods are carried out on leased land for a series of years.

*Cooperation.*—Local boards of trade and farmers.

*Location.*—Timmons ville and Manning, S. C.

*Date begun.*—1910.

*Results.*—The chief feature of the work has been the demonstration of a method of control of nematode or root-knot on tobacco by the use of crop rotations in which crops more or less immune to the parasite are grown, especially Iron or Brabham cowpeas, the small grains, and corn. Considerable data have been obtained on the fertilizer requirements of the tobacco crop and on the best systems of rotation for maintaining the productivity of tobacco soils without injuring the quality of the tobacco.

*Assignment.*—E. H. Mathewson, J. P. Young.

*Proposed expenditures, 1918-19.*—\$3,400.

**Pennsylvania Cigar-Filler Tobacco Investigations:**

*Object.*—To improve the yield and quality of cigar filler and binder leaf by breeding and selection, and to develop better methods of growing, curing, and handling.

*Procedure.*—Selected strains of standard filler and binder varieties are tested as to yield and quality, fertilizer plat tests for improving the burning qualities and the yield of tobacco are carried out, and new cultural and curing methods are investigated. The seed-selection and fertilizer tests will be continued and more attention given to curing methods.

*Cooperation.*—Pennsylvania Experiment Station.

*Location.*—Ephrata and Lock Haven, Pa.

*Date begun.*—1910.

*Results.*—Improvements in methods of handling seed beds, particularly steam sterilizing for the control of diseases and weeds, have been introduced, and a bulletin giving details of the methods has been issued. Steaming seed beds is coming into wide use in the Lancaster district. It has been found that the use of improper fertilizers, especially those containing chlorine, has been largely responsible for poor burning qualities of the leaf tobacco. The Slaughter type of Pennsylvania Broadleaf, developed in the breeding work, is proving very satisfactory both to the growers and the dealers and promises to be a means of largely standardizing the tobacco crop of Lancaster County. Cooperative tests with farmers on the profitableness of acid phosphate as a supplement to barn manure for the tobacco crop were continued during the past year, and, in general, satisfactory results have been obtained.

*Assignment.*—Otto Olson.

*Proposed expenditures, 1918-19.*—\$3,000.



**Wisconsin Cigar-Binder Tobacco Investigations:**

*Object.*—To improve the yield and quality of the tobacco crop and to study and develop methods for the control of tobacco root-rot, black-rot, and other diseases attacking the tobacco in the field and after the crop has been harvested.

*Procedure.*—Investigations are undertaken to develop, through breeding and selection, and to test improved types of binder leaf; to ascertain by field tests the fertilizer requirements of the Wisconsin tobacco crop; to develop systems of crop rotation adapted to the requirements of the tobacco; to develop methods of controlling root-rot and other field diseases, including the breeding of resistant types; and to devise methods of controlling black-rot and other diseases in the curing and handling of the tobacco.

*Cooperation.*—College of Agriculture, University of Wisconsin.

*Location.*—Madison, Wis.

*Date begun.*—1916.

*Results.*—Thus far attention has been centered on the field control of root-rot by developing types of tobacco highly resistant to the disease. Types of Havana Seed have been obtained which show marked resistance to the root-rot and give promise of furnishing an effective method of control. Control of this and other diseases in the seed bed has been accomplished by the introduction of steam sterilization of the beds. Progress has been made in the study of black-rot, must, and other diseases of the cured leaf.

*Assignment.*—James Johnson, C. M. Slagg.

*Proposed expenditures, 1918-19.*—\$3,000.

**Miscellaneous Tobacco Investigations:**

*Object.*—To study the physiology, pathology, and chemistry of the tobacco plant in their relation to improved methods of growing, curing, fermenting, and handling the crop. This work supplies the fundamentals for the practical work in improving methods of tobacco production.

*Procedure.*—Work is carried on in laboratory, greenhouse, and field. The nature of the ripening, curing, and fermentation processes, the optimum conditions required, and the diseases met with are investigated. Causes of poor burning qualities and other properties are studied through chemical analyses and histological examination. Mosaic and other important diseases are studied by laboratory and greenhouse methods. The ripening and fermentation processes are also receiving special attention.

*Location.*—Arlington Farm, Va., and Washington, D. C.

*Date begun.*—1906.

*Results.*—The nature of the "grain" of leaf tobacco and the relation of the grain development to burning qualities have been discovered and the details of the work published in the Journal of Agricultural Research. The nature of the curing and the chemical changes taking place in the process have been thoroughly studied and the results published in several bulletins. The causes of poor burning qualities have been studied and a bulletin has been issued on the subject. More recently results of importance on the nature of the ripening process of the leaf and factors controlling the process have been obtained. Much data have been accumulated on the nature of the fermentation process, the factors influencing it, and the conditions responsible for the heavy losses from black-rot and other fungous diseases during fermentation. In extensive studies on the mosaic disease it has been discovered that certain insects are responsible for its dissemination, and strong evidence has been obtained that the disease is parasitic. A number of papers have been published on this important disease. A great deal of information has been obtained as to the conditions influencing the nicotine content of tobacco and types of tobacco characterized by a high and a low content of nicotine, respectively, are being developed.

*Assignment.*—W. W. Garner, C. S. Ridgway, C. W. Bacon.

*Proposed expenditures, 1918-19.*—\$3,700.

**Total, Tobacco Investigations, \$36,460, including \$4,460 statutory.**



## [Research.]

## PAPER-PLANT INVESTIGATIONS.

## Paper-Plant Investigations:

*Object.*—To investigate the value and suitability for paper-making purposes of various wild and cultivated plants and crop wastes, relevant paper-making processes and their application to such materials, the availability of these materials, and the conditions under which they are produced and assembled for market; and to breed such plants as may have a paper-making value.

*Procedure.*—Chemical and physical experiments are conducted in the investigation of plants to ascertain the best method of treatment. Laboratory work in the manufacture of sample sheets of paper is done to demonstrate the value of process and product. Paper-making tests on a large scale are conducted, in cooperation with manufacturers, to demonstrate the value of materials under commercial conditions of manufacture. Field investigations are made regarding the availability of materials and agricultural and assembling conditions.

*Cooperation.*—North Dakota Agricultural College and Bureau of Chemistry; cooperative mill tests with commercial companies at Cumberland Mills and Bar Mills, Me., Bridgeport, Pa., St. Paul and Winona, Minn., and Lawrence, Kans.

*Location.*—Washington, D. C.; mill tests as shown under "Cooperation."

*Date begun.*—1907.

*Results.*—(1) Prior to 1918: Cooperative mill tests have demonstrated the possibility of making satisfactory and merchantable paper from corn-stalks, broom corn, hemp stalks, hemp flyings, zacaton (*Epicampes macroura*), and *Yucca treculeana*; also the possibilities of utilizing flax tow in the manufacture of counterboards.

It has been found that hemp hurds can be utilized in the manufacture of high-grade printing and book papers, but, since it has not appeared that this material can as yet be produced in commercial quantities, these investigations were discontinued. Mill tests on flax straw have shown that this material may be utilized in the production of trunk and fiber boards; the product resulting from the tests was sold in the open market at the price regularly received for similar articles. Flax straw has been demonstrated to be suitable for employment in the manufacture of tough wrapping, cement-sack, and flour-sack papers. Mill tests concerning the possibilities of utilizing flax straw commercially have been conducted on an extensive scale. Publications: Yearbook Separate 541, Bureau of Plant Industry Circular 82, and Department Bulletins—309, "Zacaton as a Paper-Making Material," and 322. "Utilization of American Flax Straw in the Paper and Fiber Board Industry."

(2) During 1918: The principal work during the past year has been in connection with the manufacture of a better grade of flax tow than is now manufactured for use in the paper industry, with a view to produce a higher grade of paper than can be made from flax straw or low-grade flax tow. An experimental tow machine has been constructed to make this better tow, and the process has been patented. From this high-grade tow a bleached bond paper has been produced in an experimental way. A semicommercial machine is now under construction along the same lines as the experimental machine, 200 tons of flax straw have been purchased, and various methods of retting have been tried. Extensive towing tests and semicommercial paper tests are planned. Plans are also under advisement for producing a cleaner grade of straw by separating all the chaff at the time of threshing, and different appliances are to be tried out on the thresher.

*Assignment.*—Charles J. Brand, Jason L. Merrill.

*Proposed expenditures, 1918-19.*—\$19,880, including \$3,120 statutory.



## [Research.]

## ALKALI AND DROUGHT RESISTANT PLANT INVESTIGATIONS.

## SUPERVISION.

**Supervision:**

*Object.*—To execute administrative affairs and conduct correspondence and laboratory work in connection with investigational projects.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Assignment.*—T. H. Kearney, H. L. Shantz.

*Proposed expenditures, 1918-19.*—\$5,000, including \$2,180 statutory.

## BREEDING AND PHYSIOLOGY OF ALKALI AND DROUGHT RESISTANT PLANTS.

**Investigating the Alkali Resistance of Crop Plants:**

*Object.*—To ascertain by laboratory investigations and by field observations the relative adaptability of crop plants to alkali soils, and to study the physiological effects of alkali as a basis for the more scientific handling of crops grown on such soils.

*Procedure.*—Observations are made in the field and in the laboratory upon different crop plants growing in alkali soils, in order to ascertain how the alkali affects them and to determine what species and varieties are most resistant. These observations form the basis for recommendations of crop plants adapted to growing on alkali soils. Further information concerning the behavior of different crop plants in different types of alkali soil will be collected as a basis for recommendations to farmers concerning what crops to grow on alkali land.

*Location.*—Laboratory work at Washington, D. C.; field work at various points in Arizona, California, Nevada, Utah, Colorado, and other Western States where irrigation is extensively practiced.

*Date begun.*—1907.

*Results.*—(1) Prior to 1918: Many of the important field crops grown under irrigation in the western United States have been tested on alkali land and their comparative adaptability to these conditions determined. Suggestions regarding what crops and cultural methods are most likely to succeed on alkali land have been published. The use of crops in the reclamation of alkali land and the specific effects upon plant growth of the different alkali salts have been investigated.

(2) During the past year, owing to the pressure of other lines of investigation, work on this project was confined to answering letters of inquiry concerning crops adapted to alkali soil and to occasional field observations on the alkali resistance of special crops.

*Assignment.*—T. H. Kearney.

*Proposed expenditures, 1918-19.*—\$1,000.

**Investigating the Physiology of Drought Resistance:**

*Object.*—To determine the causes of drought resistance by investigating the function and structure of crop plants, and to furnish a physiological basis for plant breeding, variety testing, and investigations of cultural methods in connection with dry-land agriculture.

*Procedure.*—Field observations are made upon the structure and functions of crop plants when the water supply is deficient. Measurements are made of the quantity of water used by the different species and varieties in producing a given weight of dry matter, in order to determine their relative efficiency in the use of water. The results of these observations and experiments make it possible to determine the comparative drought resistance and the adaptability to dry-land agriculture of the different crop plants. The lines of work indicated above will be continued during the next year without any change in general plans.

*Location.*—Laboratory work at Washington, D. C.; field work at bureau experiment farms at Chula Vista, Cal., Huntley, Mont., Yuma, Ariz., Moro, Oreg., Newell, S. Dak., and Arlington Farm, Va.

*Date begun.*—1908.

*Results.*—(1) Prior to 1918: Most of the important crop plants grown in the western United States have been investigated in regard to their relative ability to reduce the moisture content of the soil and the relative



amount of moisture required to produce a pound of dry matter. The different crop plants have been found to differ greatly in the quantity of water used in producing a given weight of crop. In a general way, the crops which are most efficient in this respect are those which are most successful in withstanding drought. Measurement of water requirement has therefore proven to be a practical method for determining what crops and what varieties of each crop are most likely to succeed when grown without irrigation in a dry climate.

(2) During 1918: Measurements of water requirement and of the effects of weather conditions upon transpiration were continued at a number of field stations. In addition to the field crops which have hitherto been studied, an investigation of the water requirement of citrus trees in California has been commenced.

*Assignment.*—H. L. Shantz, C. F. Griswold.

*Proposed expenditures, 1918-19.*—\$7,000.

### **Indicator Value of Native Vegetation in Arid Regions:**

*Object.*—To work out methods for utilizing native vegetation in classifying new land as to its agricultural value by establishing correlations between different types of natural growth and the soil moisture and alkali conditions of the corresponding types of land.

*Procedure.*—In a given area the different types of native vegetation are classified and the character of the land upon which each type occurs determined, special attention being given to the moisture relations and salt content of the soil. If crops are being grown, the yield and behavior of the cultivated plants are studied in order to correlate the crop-producing capabilities of the land with the kind of native growth which it originally produced. When these correlations have been worked out in detail in a limited area it becomes possible to classify land with respect to its agricultural capabilities throughout the region where these particular types of vegetation occur. During the coming year it is proposed to continue, in cooperation with the Land Classification Board and the Bureau of Soils, the practical application of the methods worked out in this investigation. As opportunity offers, the scientific investigations will be continued in other portions of the semiarid West.

*Cooperation.*—Bureau of Soils of this department and Land Classification Board of the Interior Department.

*Location.*—Arid and semiarid portions of United States.

*Date begun.*—1910.

*Results.*—(1) Prior to 1918: The different types of vegetation in the Great Plains, Great Basin, and southwestern desert regions have been shown to be closely correlated with the physical properties and crop-producing capabilities of the soils on which they occur. The possibility of utilizing the native vegetation in classifying new land with respect to its suitability for crop production by dry-farming methods or under irrigation has been demonstrated by these investigations.

(2) During 1918: Practical demonstrations were made of the utility of the methods worked out by these investigations. Field work was carried on in connection with a soil survey conducted by the Bureau of Soils in Arizona and in connection with the classification of land under the stock-raising homestead law by the Land Classification Board of the Department of the Interior.

*Assignment.*—T. H. Kearney, H. L. Shantz.

*Proposed expenditures, 1918-19.*—\$2,500.

### **Breeding Drought-Resistant Field Crops:**

*Object.*—To work out methods for breeding more drought-resistant strains of field crops adapted to dry-land agriculture, and to devise improved methods of testing comparative drought resistance.

*Procedure.*—Individual plants are selected which give indications in their structure and behavior of superior drought resistance, and their progenies are compared with respect to their adaptability to conditions of scanty moisture supply, water requirement, productiveness, and general desirability. Commercial varieties commonly grown in the region are used as checks in estimating the degree of improvement attained. Those strains which prove to be best adapted to conditions of drought without impairment of other valuable qualities are chosen for distribution to farmers through the Office of Seed Distribution. Effort will be directed



mainly to increasing and distributing to farmers the superior varieties which have been developed. It is also planned to continue the breeding work and the study of methods for testing drought resistance.

*Location.*—Newell and Ardmore, S. Dak., Akron, Colo., and Mandan, N. Dak.

*Date begun.*—1908.

*Results.*—(1) Prior to 1918: Selected strains have been bred of sorgo (Dakota Amber), millet (Dakota Kursk), alfalfa, and smooth brome grass suitable for dry-land agriculture in the Great Plains region. The methods of breeding and descriptions of the new varieties obtained have been published.

(2) During 1918: The improved sorgo and millet are becoming established in the northern portion of the Great Plains, the seed having been increased by farmers and distributed through the Office of Seed Distribution. The best new strains of alfalfa and brome grass are now being increased with a view to their distribution in the same region.

*Assignment.*—T. H. Kearney, A. C. Dillman.

*Proposed expenditures, 1918-19.*—\$3,650.

### **Breeding and Culture of Pomegranates:**

*Object.*—To obtain by introduction and breeding drought-resistant and alkali-resistant varieties of pomegranates.

*Procedure.*—Through the Office of Foreign Seed and Plant Introduction promising varieties of pomegranates have been introduced from various foreign countries and are being tested side by side at a number of stations in the southwestern United States. The different varieties are compared with respect to their adaptability to the local climatic and soil conditions, their yield, and the size and quality of their fruit. Those which give the best results are propagated for distribution to growers in the region to which they have proven adapted.

*Location.*—Sacaton, Ariz., Bard and Indio, Cal., and San Antonio, Tex.

*Date begun.*—1907.

*Results.*—(1) Prior to 1918: Selection has been made of a number of the most promising varieties in the experimental gardens at Chico, Cal., and Sacaton, Ariz., and these have been propagated and distributed to growers of the fruit in the Southwestern States. In cooperation with the Office of Indian Affairs, rooted plants of the best varieties in the collection at Sacaton have been distributed to Indians on the Pima Reservation.

(2) During 1918: Further progress has been made in selecting, propagating, and distributing the best varieties.

*Assignment.*—T. H. Kearney.

*Proposed expenditures, 1918-19.*—\$200.

**Total, Breeding and Physiology of Alkali and Drought Resistant Plants, \$14,350.**

### **EGYPTIAN COTTON BREEDING.**

#### **Egyptian Cotton Breeding and Alkali-Resistance Investigations in the Arid Southwest:**

*Object.*—To secure varieties of Egyptian cotton yielding fiber of superior quality and thoroughly adapted to growing under irrigation in the southwestern United States.

*Procedure.*—Ordinary methods of plant breeding (selection and hybridization) are followed. The most promising strains are tested on a field basis, and seed of the one which yields best and of which the fiber gives the best results in spinning tests is distributed to farmers. Studies are made of the behavior of the plants on soils having different salt content and different moisture conditions, in order to ascertain what soils are best adapted to this crop. Plant-breeding work will be continued in order to obtain varieties adapted to special requirements of the manufacturers and to the climatic and soil conditions of new localities where production of this type of cotton is being undertaken. In order to maintain the present varieties, cooperative work with the growers' associations will also be continued. The great demand among manufacturers of tire fabrics for cotton of this type and the likelihood of its being required by the Government for military purposes, together with the uncertainty of obtaining a sufficient supply from Egypt while the war continues, make it desirable to develop production in this country as rapidly as possible.

*Cooperation.*—Cooperative associations of cotton growers (pure-seed work); Bureau of Markets (fiber tests).



*Location.*—Plant-breeding work on the experimental farms at Sacaton, Ariz., and Bard, Cal.; in maintaining pure seed supplies, in cooperation with growers' associations, at several localities in Arizona and California.

*Date begun.*—1907.

*Results.*—(1) Prior to 1918: Two new types of Egyptian cotton, the Yuma and the Pima, have been developed by selection from one of the varieties grown in Egypt. The fiber of the first variety is about  $1\frac{1}{2}$  inches long and that of the second variety about  $1\frac{3}{8}$  inches long. Both have proven to be valuable in the manufacture of various classes of goods for which long and strong fiber is required, especially the so-called "mechanical fabrics."

(2) During 1918: Approximately 20,000 bales (of 500 pounds) of Egyptian cotton were produced in Arizona in 1917, of which 3,000 bales were of the new Pima variety and the remainder of the Yuma variety. Very high prices were obtained, and as a result it is estimated that about 100,000 acres will be grown in Arizona and California in 1918. Nearly three-quarters of the total acreage will be of the Pima variety.

The plant-breeding investigations and the cooperative work in maintaining a pure supply of planting seed of the Pima variety were continued during the past crop season. Breeding work is also being carried on with Sakellaridis, the principal variety grown in Egypt, which is preferred by some American spinners on account of special properties of its fiber.

*Assignment.*—T. H. Kearney, W. G. Wells.

*Proposed expenditures, 1918-19.*—\$6,610.

#### ECOLOGY OF CROP PLANTS.

##### Ecology of Crop Plants:

*Object.*—To apply physiological and ecological methods to the problem of plant production, and, by comparative study of the physiological processes and the individual response of plants to a wide range of climatic conditions, to determine the individual peculiarities of plants as a means of explaining their success or failure under cultivation in any particular environment.

*Procedure.*—The structure, functions, and growth of crop plants under a wide range of field conditions are studied with a view to determine what peculiarities of structure and functions are of importance in adapting these plants to different environments and particularly to different conditions of light, heat, atmospheric humidity, and soil-moisture supply.

*Location.*—Laboratory work at Washington, D. C.; field work at various field stations operated by the Bureau of Plant Industry.

*Results.*—(1) Prior to 1918: The effects of various temperatures on a number of crop plants were studied, and marked differences in growth and in morphological and physiological characters between closely related forms were found to exist.

(2) During 1918: The pressure of other work made it necessary to temporarily suspend investigations under this project.

*Date begun.*—1916.

*Assignment.*—H. L. Shantz.

*Proposed expenditures, 1918-19.*—\$500.

**Total, Alkali and Drought Resistant Plant Investigations, \$26,460, including \$2,180 statutory.**

[Research.]

#### SUGAR-PLANT INVESTIGATIONS.

##### SUPERVISION.

##### Supervision:

*Object.*—To administer the funds, handle correspondence, keep all records, and give general oversight to the field, laboratory, and office work.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Assignment.*—C. O. Townsend.

*Proposed expenditures, 1918-19.*—\$7,200, including \$2,200 statutory.

## SUGAR-BEET INVESTIGATIONS.

**Investigation of the Status of the Sugar-Beet Industry in the United States:**

*Object.*—To determine the present status of the sugar-beet industry in each general locality where the industry now exists; to determine what the limiting factor or factors for sugar-beet production are in each sugar-beet center; to determine whether or not the limiting factor or factors, so far as sugar-beet growing is concerned, are surmountable from an economic standpoint.

*Procedure.*—An economic farm-to-farm and factory survey is being made in the sugar-beet centers, in which all the factors, both direct and indirect, that have any bearing upon sugar-beet growing, harvesting, and delivery are being considered and given their proper value, with due regard to the place and value of other crop and live-stock interests on the farm as a unit and the community as a whole.

*Cooperation.*—Office of Farm Management; Office of Extension Work in the Northern and Western States; sugar companies and individual farmers.

*Location.*—California, Colorado, Idaho, Michigan, Nevada, Ohio, Utah, Wisconsin, Indiana, Illinois, Minnesota, Nebraska, Kansas, Montana, Wyoming, and other sugar-beet producing States.

*Date begun.*—1914.

*Results.*—A general survey has been made of all existing sugar-beet areas, and some of the limiting factors, with methods of control, have been pointed out to those directly interested. Two Farmers' Bulletins relating to sugar-beet culture have been revised and one new bulletin is in process of publication.

*Assignment.*—C. O. Townsend.

*Proposed expenditures, 1918-19.*—\$15,515.

**Economic Practice in Crop Production in Sugar-Beet Areas:**

*Object.*—To determine what relations, if any, exist between sugar-beet and the other farming and live-stock operations now existing in a given territory.

*Procedure.*—An economic farm-to-farm survey covered by the original survey plus the survey covering the production, harvesting, marketing, and other factors bearing directly or indirectly upon the possible new lines of agriculture is being made. An endeavor is made to enlist the cooperation of all the best farmers in each community in doing the things that will lead to the best system of crop rotation and live-stock production, with a view to establish an improved, permanent, and progressive agriculture. This work also includes a study of local cultural methods with a view to their improvement, the cause and control of beet diseases, local labor and marketing conditions, and all other factors that bear upon the production and handling of the sugar-beet crop, so that the grower will receive the largest possible returns for money and labor invested. In case of radical changes in local agricultural methods or crop production, specific demonstrations are necessary to accomplish the desired result.

*Cooperation.*—Office of Farm Management, States Relations Service, farmers' organizations, sugar companies, and individual farmers.

*Location.*—Chino, Huntington, Beach, Santa Ana, and Betteravia, Cal.; Lehi, Utah; Aberdeen and Idaho Falls, Idaho; Billings, Mont.; Fort Collins, Fort Morgan, Greeley, and Rocky Ford, Colo.; Blissfield, Mich.; Toledo, Ohio, and other points in the States mentioned.

*Date begun.*—1914.

*Results.*—Approximately 2,000 individual farm records have been obtained. These data are taken back to the farmers in the form of illustrated lectures, multigraphed letters, printed matter, and field demonstrations and by means of personal interviews. One bulletin has been issued and five others are in course of publication.

*Assignment.*—C. O. Townsend.

*Proposed expenditures, 1918-19.*—\$16,000.

**Sugar-Beet Seed Production:**

*Object.*—To determine the conditions under which an adequate supply of sugar-beet seed may be produced in this country in an emergency; to



determine the conditions under which commercial beet-seed production may be made a permanent part of our agricultural operations, thereby insuring a stable agriculture for those sections in which sugar beets appear to be vital to the best interests of the farmer; to determine the correlation between the external character of the beet and the quality (sugar, purity, and yield) of the root, and to breed out a line of beets in which the quality (sugar, purity, and yield) of the roots will correspond to one or more well-defined external characters of leaf and root, with due regard to quality and yield of seed.

*Procedure.*—Beet growers, sugar companies, and seedsmen are being advised and assisted in the various steps needed in commercial beet-seed production. This involves all the steps from the growing, selection, and storing of the roots on a large scale to the harvesting and cleaning of the mature seed. The conditions under which a paying crop of satisfactory beet seed may be produced commercially each year are being studied and the relations of soil and climatic conditions, methods of handling the roots, and the influence of pests and other factors on the successful production of commercial sugar-beet seed determined. Present known types or strains of sugar beets are being selected from those individuals of distinctive type or character which show the best quality and yield of seed. These individuals are bred by the plant-to-row method until the desired type is fixed, that is, until a given type of leaf and root comes true and indicates quality and yield of seed and roots. Wild beets are grown and tested along the lines indicated above, with the hope of finding a type that will give better results than any of the present domestic types. In case one type shows quality and another shows yield, they are crossbred and a new strain originated combining quality and yield, and from this will be developed a pure strain having these combined characters. These strains must be widely separated during the season of seed production to keep them pure.

All the above work is coördinated so that the production of commercial sugar-beet seed for emergency purposes and the determination of the adverse and favorable factors influencing the annual production of the crop will fit into the economic factors of the improvement of the beet root and the cost of seed production.

*Cooperation.*—Bureau of Chemistry, State experiment stations, beet-sugar companies, beet-seed growers, seedsmen, and individual farmers.

*Location.*—Blissfield, Mich.; Rocky Ford and Fort Collins, Colo.; Lehi and Garland, Utah; Aberdeen, Idaho Falls, and Sugar City, Idaho, and other points in the sugar-beet States.

*Date begun.*—1915.

*Results.*—Several thousand acres of sugar-beet seed are produced in the United States each year, and the area is constantly increasing. A large number of selections of individual plants have been made. These plants have been carefully described, photographed, and the roots tested, thus laying the foundation for a highly developed strain of American-grown sugar-beet seed. A Department Yearbook paper on "The Present Status of the Sugar-Beet Seed Industry in the United States" has been published.

*Assignment.*—C. O. Townsend.

*Proposed expenditures, 1918-19.*—\$16,000.

**Total, Sugar-Beet Investigations, \$47,515.**

(See also Supplement—Emergency Activities, p. 558.)

#### SUGAR-CANE AND SORGHUM INVESTIGATIONS.

##### Sugar-Cane Sirup Production:

*Object.*—To conduct investigations in connection with the manufacture of table sirup, with special reference to its production on the farm, including studies of the breeding, culture, and diseases of sugar cane, the methods of manufacture, standardization, and marketing of sirup, the utilization of sugar-cane by-products, and the correlation otherwise of the sugar cane and sirup industry with other farm industries.

*Procedure.*—The promising standard varieties of sugar cane now used in the sirup belt are being tested in field plots at one or more places to determine which ones are best adapted to the production of a good yield and a high quality of sirup. New and promising varieties of sugar cane, es-



pecially quick-maturing, high-yielding, and strong-rattooning varieties and strains resistant to red-rot and other diseases, are being introduced from other parts of the world and tested in the sirup belt after they have been grown for a period of time at quarantine stations to prevent the introduction of serious diseases or insect pests. Experiments are being conducted with various methods of culture, types of soil, fertilizers, and crop rotations to determine which are the more advantageous for the production of sugar cane in the sirup-making sections. Diseases of sugar cane are being studied and methods for their control worked out. Efforts are being made to improve sirup-making machinery and operations, with the aim of improving the quality of the product, of securing greater uniformity in it, of increasing the yield, and of cheapening the process, with special reference to farm outfits for sirup making. Sirup is produced from the cane crops grown on the various experimental plats and suitable tests made of the quality of the juice and sirups resulting. Experiments are conducted in the utilization of sugar-cane by-products, such as tops, bagasse, and skimmings. Trips are occasionally made through sirup-producing sections of the South to study the same problems on the commercial farms and, in addition, to make a survey of varieties of sugar cane in use, their characteristics, and the names by which they are known and to study the diseases of the cane and such other problems as are thus brought to the attention of the employees making these trips.

*Cooperation.*—Individual farmers and sugar-cane growers in Georgia and Florida and other cane-growing States.

*Location.*—Cairo, Ga., and other points in the cane-producing States.

*Date begun.*—1913.

*Results.*—Three years' data have been collected on the tests of seven varieties well known in some sections of the sugar-cane producing States. From one to three years' data have also been collected with some of the rarer or newly introduced varieties, a few of which show much promise. On the experiment farm a total of 38 varieties are now growing, of which 32 are new to this locality. Three years' data have also been collected on a number of cultural tests in the field, including among others tests on spacing and rate of planting, time of planting, length of cuttings to plant, furrows fresh versus furrows dry at time of planting, and subsoiling. Tests have been made during these years on the utilization of tops, pomace, and skimmings and on the time and manner of storing seed cane and of treating seed cane to lessen the loss during winter storage from red-rot. A plant for making sirup from the cane produced on the experimental plats has been built, which, while designed especially for the experimental requirements, incidentally serves for convenience and efficiency as a model plant in many respects. New sirup-making apparatus invented and designed include a steam-bottom sirup evaporator, two types of density indicators, a simple outflow regulator, an inflow valve, and an automatic inflow regulator. A patent has been granted on the steam-bottom sirup evaporator, making it available to citizens of the United States free of any royalty or similar restrictions. A bulletin on "Sugar Cane Culture for Sirup Production in the United States" has been issued. This includes also a discussion of the farm economics of the sirup industry. (The first edition is now exhausted.) Bulletins are in preparation on sirup making on the farm, precautions against loss by red-rot in seed cane during winter storage, diseases of sugar cane in the United States, and *Helminthosporium sacchari* in sugar cane. Much material and drawings are collected and prepared in the study of varietal characteristics of sugar canes in the United States.

*Assignment.*—C. O. Townsend, P. A. Yoder.

*Proposed expenditures, 1918-19.*—\$7,000.

### **Sorghum Sirup Production:**

*Object.*—To investigate the relation of the production of sweet sorghum to the other operations on the farm, to develop and improve sweet-sorghum varieties, and to investigate the nature and control of sorghum diseases and all other limiting factors bearing upon the cultivation and utilization of this crop for sirup production, with a view to so improve the yield, quality, and uniformity of the grade of the finished product that it will have a more general use on the farm and a wider and more profitable market.



*Procedure.*—Study is being made of the conditions on the individual farms where sorghum is produced in as many sorghum-growing localities as possible, giving special attention to size and type of farm, crop rotation, and live-stock and labor conditions, with special reference to the bearing of these and all other factors upon the yield, quality, and value of the sirup produced. The effect of soil and climate and other factors upon each variety in different localities will be determined by a study of commercial fields and by plot experiments. An effort will be made to produce new varieties by selection and breeding, and these will be tested for yield, quality, hardness, resistance to disease, richness, etc. The factors which influence the color and quality of the sirup will be sought, with a view to produce a standard grade; also the factors which influence the keeping quality of the finished product. Implements required in producing and handling the crop will be devised or improved, with a view to reduce the cost of production. The use of bagasse for stock feed, paper making, fertilizer, etc., will be investigated, in order to find the most profitable use of this by-product.

*Cooperation.*—Bureau of Chemistry, Office of Farm Management, States Relations Service, Office of Paper-Plant Investigations, farmers, and sorghum-sirup makers.

*Location.*—Kentucky, Tennessee, Missouri, Arkansas, and other sweet-sorghum producing States.

*Date begun.*—1817.

*Assignment.*—C. O. Townsend, H. B. Cowgill.

*Proposed expenditures, 1918-19.*—\$4,600.

**Total, Sugar Cane and Sorghum Investigations, \$11,600.**

(See also Supplement—Emergency Activities, p. 559.)

**Total, Sugar-Plant Investigations, \$66,315, including \$2,200 statutory.**

#### [Research.]

### INVESTIGATIONS IN ECONOMIC AND SYSTEMATIC BOTANY.

#### SUPERVISION.

##### Supervision:

*Object.*—This covers the supervisory and routine work of the office and laboratory, including the investigations carried on in the greenhouse.

*Procedure.*—It is part of the duty of the office to furnish the various branches of the department the correct names of plants the identity of which is a matter of importance in their work. For this purpose the office employs expert botanists and maintains a herbarium of cultivated plants (used to supplement the National Herbarium, which is under the Smithsonian Institution).

*Cooperation.*—National Herbarium.

*Location.*—Washington, D. C.

*Date begun.*—1868.

*Assignment.*—Frederick V. Coville.

*Proposed expenditures, 1918-19.*—\$6,174, including \$3,934 statutory.

#### BIBLIOGRAPHICAL WORK IN THE INTEREST OF BOTANICAL SCIENCE.

##### Bibliographical Work in the Interest of Botanical Science:

*Object.*—To improve bibliographical facilities for botanical workers in Washington.

*Procedure.*—A card catalogue, both subject and author, is maintained, which not only represents the resources of the Washington libraries in botany and horticulture, but also, by the inclusion of entries for books that are needed, serves as a guide in the purchase of works on these subjects. Index entries for current scientific serials or society publications are included. A list of scientific serials or society publications containing botanical or horticultural material is also maintained. A bibliography of horticulture is in process of compilation. An index of botanical illustrations to supplement Pritzel's *Icones* is in progress.

*Cooperation.*—Department library and Library of Congress.

*Location.*—Washington, D. C., and various large libraries of other cities.

*Date begun.*—1903.

*Assignment.*—Majorie F. Warner, Alice C. Atwood.

*Proposed expenditures, 1918-19.*—\$2,800, including \$2,600 statutory.



## RANGE INVESTIGATIONS.

**Range Investigations:**

*Object.*—To develop increased forage on the overgrazed range lands of the national forests and elsewhere.

*Procedure.*—Methods are devised for the improvement of wild grazing lands, in cooperation with the Forest Service. This office furnishes expert advice and attends to the technical botanical phases of the work. Most of the details of the investigation are carried out by the Forest Service.

*Cooperation.*—Forest Service.

*Location.*—Washington, D. C., and Western States.

*Date begun.*—1907.

*Results.*—It has been demonstrated that overgrazed areas can be abundantly revegetated, without the necessity of closing them to stock, by timing annual grazing to permit seed formation. Furthermore, grazing at proper seasons results not only in a greater yield for the year but in increased root vigor and the consequent ability of the plants to produce heavier yields in succeeding years. Sheep fenced in and not herded or sheep handled under the open-herding system produce more wool and mutton on much less range than by the ordinary methods.

*Assignment.*—Frederick V. Coville, Ivar Tidestrom.

*Proposed expenditures, 1918-19.*—\$2,143, including \$233 statutory.

## ECONOMIC BOTANY OF NATIVE PLANTS.

**Economic Botany of Mexico, with Special Reference to the Utilization of Valuable Species in the United States:**

*Object.*—To make available for public use information on the useful native plants of Mexico.

*Procedure.*—This project involves a study of material in the department's economic collection of plants, roots, and fruits, and vegetable products submitted for identification; the acquisition of supplementary material when necessary, and consultation with experts in the various offices of the Bureau of Plant Industry, Forest Service, Bureau of Chemistry, and the United States National Museum, in order to obtain reliable information; the correlation of all collectors' notes and statements of those submitting plant products for study with information already published as to the properties of the plants under study; the identification of important economic plants, drugs, dyestuffs, resins, balsams, spices, fruits, and other plant products described by early explorers and writers with material in the department's collections; finally, the systematic grouping of these facts and the publication of descriptions of species which prove to be new to science.

*Cooperation.*—National Herbarium and Bureau of American Ethnology.

*Location.*—Washington, D. C.

*Date begun.*—1899.

*Results.*—An enormous quantity of material collected by Dr. Edward Palmer and others in Mexico and adjoining countries has been studied. The results are embodied in a manuscript, not yet in shape for publication, which is intended as the basis of a handbook of the useful plants of tropical and subtropical America. The need for such work is indicated by frequent inquiries, to which answers are made for the most part by copying parts of the manuscript mentioned. These inquiries are wide in their scope, touching food and forage plants, drugs, tanning and dye plants, narcotics, poison plants, oils, copals, balsams, and gums. They come from the War and Navy Departments, the Department of Commerce, the National Museum, Bureau of Fisheries, the Forest Service, various offices of the Bureau of Plant Industry, and from the Bureaus of Animal Industry and Chemistry. They are also received from public economists, from commercial and manufacturing firms, applicants for patent medicines, and other private individuals.

The following publications have recently been issued: "Identity of Cohoba, the Narcotic Snuff of Ancient Haiti," *Journal of the Washington Academy of Sciences*, vol. 6, 547-562, 1916; "Food Plants and Textiles of Ancient America," *Proceedings of the Nineteenth International Congress of Americanists*, 12-30, 1917, also in *Proceedings of the Second Pan-American Scientific Congress*, 1:146-159, 1917; "A Forgotten Cereal of Ancient America," *Proceedings of the Nineteenth International Con-*



gress of Americanists, 286-297, 1917; "Narcotic Plants and Stimulants of the Ancient Americans," Smithsonian Report for 1916, 387-424, 1917.

*Assignment.*—W. E. Safford.

*Proposed expenditures, 1918-19.*—\$3,716.

### **Plants Used by the American Aborigines:**

*Object.*—To record information possessed by the aborigines regarding the uses of plants.

*Procedure.*—All available literature on exploration, early travels, and settlement in this country, as well as publications of a later date, that have a bearing on aboriginal matters are consulted in various libraries with reference to plant subjects. The information thus found is abstracted and filed under the botanical name of the plant referred to. An index of authors and works consulted is also made.

*Cooperation.*—National Herbarium and Bureau of American Ethnology.

*Location.*—Washington, D. C., and Western States.

*Date begun.*—1891.

*Results.*—A paper entitled "Grasses Used by the Indians" has been prepared. An index and abstracts leading to a series of manuscripts for publication have been partially completed. A paper entitled "Natural History of Paradise Key and the Nearby Everglades of Florida" has been completed. This includes an account of the economic plants used by the Seminole Indians and their predecessors in southern Florida. It will be published in the Smithsonian Report for 1917.

*Probable date of completion.*—1924.

*Assignment.*—W. E. Safford.

*Proposed expenditures, 1918-19.*—\$2,130.

**Total, Economic Botany of Native Plants, \$5,846, including \$900 statutory.**

### **BOTANY OF THE ECONOMIC GRASSES.**

#### **Manual of North American Grasses:**

*Object.*—To produce a descriptive manual of the grasses of the United States.

*Procedure.*—Material is gathered from the region covered and arranged and studied. All possible information from literature is collected. Individual groups of grasses which are finally to be published in monographic form are studied. During the summer of 1918 it is proposed to carry on field work in Louisiana, Arkansas, Texas, Oklahoma, Kansas, and Colorado.

*Cooperation.*—National Herbarium.

*Location.*—Washington, D. C., and various parts of North America.

*Date begun.*—1905.

*Results.*—A paper entitled "Grasses of the West Indies" has been published as Contributions from the United States National Herbarium, vol. 18, part 7; a paper on "Genera of the Grasses of the United States" has been completed except for a few drawings; a "Revision of the Genus *Paspalum* in North America" is in preparation; a paper on the "Grasses of the Pacific Slope" is completed and is to be published in a manual of that region. A mass of information is being accumulated for use in the forthcoming manual.

*Probable date of completion.*—1924.

*Assignment.*—A. S. Hitchcock.

*Proposed expenditures, 1918-19.*—\$2,646.

#### **Grass Introduction Index:**

*Object.*—To maintain a card index, containing all references to the uses of grasses except the common agricultural uses, references to common names, extracts from notes of travelers, and other information, for the purpose of assisting the Office of Foreign Seed and Plant Introduction in securing valuable grasses for introduction into the United States.

*Procedure.*—Literature is examined and its contents indexed. Preference is given to work on periodicals and other current literature, but older books are indexed as time permits.

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—Index continued and many cards added.

*Assignment.*—A. S. Hitchcock.

*Proposed expenditures, 1918-19.*—\$621.

**Economic Grass Collection:**

*Object.*—To obtain a collection of wild and cultivated grasses of the world as material for study under various grass projects.

*Procedure.*—The grass herbarium is kept in order. The specimens have to be mounted and arranged so as to make the information available in classified form.

*Cooperation.*—National Herbarium.

*Location.*—Washington, D. C.

*Date begun.*—1868.

*Results.*—The herbarium specimens from the United States have been arranged geographically so that those from a given State may be readily consulted. The grass collection has been more than doubled in the last 10 years and is now the largest in the world, containing about 130,000 sheets. Keys to the species have been prepared for all the genera in the United States, and the specimens have been arranged so as to be readily accessible and easily consulted. The material now at hand is nearly sufficient for the preparation of the remaining monographs of large genera and for the final incorporation of all the results in the Manual of North American Grasses.

*Assignment.*—A. S. Hitchcock, Agnes Chase.

*Proposed expenditures, 1918-19.*—\$2,996.

**Miscellaneous Identification of Grasses:**

*Object.*—To identify grasses sent in from various sources.

*Procedure.*—Specimens are identified as they come in and reports made on them in different forms, depending upon the character of the work.

*Cooperation.*—National Herbarium.

*Location.*—Washington, D. C.

*Date begun.*—1868.

*Results.*—Miscellaneous identifications during 1917 numbered 4,040 specimens. These specimens were submitted chiefly by other officers and bureaus of the department and by State experiment stations and educational institutions.

*Assignment.*—A. S. Hitchcock, Agnes Chase.

*Proposed expenditures, 1918-19.*—\$1,821.

**Total, Botany of Economic Grasses, \$8,084, including \$1,680 statutory.**

**SYSTEMATIC WORK IN ECONOMIC BOTANY.****Economic Collections:**

*Object.*—To preserve and identify plants and plant products.

*Procedure.*—Specimens of plants are collected at the Arlington Farm and the several trial stations of the Bureau of Plant Industry. Material is also secured from other sources, including nurseries and seedsmen's trial grounds. An herbarium is maintained in order to make the acquired information readily accessible and available.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—A working herbarium of 50,000 specimens of cultivated plants has been brought together and is in constant use for purposes of reference and study.

*Assignment.*—S. F. Blake.

*Proposed expenditures, 1918-19.*—\$1,746.

**Economic Monograph of the Heather and Blueberry Families, with Special Reference to Their Utilization in the United States:**

*Object.*—Domestication of the blueberry and other plants of these families.

*Procedure.*—Blueberry hybrids are propagated from specially selected wild stocks by new methods in the greenhouse, and field tests of these are made at a cooperative plantation in New Jersey. Plants propagated by cuttings from some of the best selected hybrids will ultimately be distributed to private individuals throughout the country, in suitable locations, for trial.

*Cooperation.*—Blueberry growers.

*Location.*—Washington, D. C., New Jersey, Rhode Island, and Massachusetts.

*Date begun.*—1908.



*Results.*—Hybrid blueberries three-quarters of an inch in diameter have already been produced. Three hybrids out of about 7,000 that have fruited up to the present time have been selected for propagation and distribution. The berries from the 5-year-old unselected hybrids sold in 1917 at an average price of a little over 24 cents per quart, delivered at the nearest railway station. The yield was at the rate of a little more than 58 bushels per acre, representing gross receipts of \$448 per acre.

*Probable date of completion.*—1930.

*Assignment.*—Frederick V. Coville.

*Proposed expenditures, 1918-19.*—\$1,173.

#### **Systematic Botany of the Forage Plants Cultivated in America, Exclusive of the Grasses:**

*Object.*—To publish taxonomic information on plants cultivated for forage in the United States.

*Procedure.*—Material is collected at the Arlington Farm, Va., and other experiment stations where various species of forage plants are in cultivation. Studies of the material are conducted in the field and in the herbarium.

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—Many identifications have been made and assistance furnished to forage-plant breeders and experimenters.

*Assignment.*—Frederick V. Coville.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

#### **Ornamental Trees and Shrubs in the American Nursery Trade:**

*Object.*—To devise an accurate classification for these plants.

*Procedure.*—Material of the class indicated growing in nurseries, parks, trial grounds, and private estates is collected and studied—both in the living state and in the herbarium.

*Cooperation.*—Nurserymen.

*Location.*—Washington, D. C., and various parts of the United States.

*Date begun.*—1910.

*Results.*—Assistance has been rendered to nurserymen and horticulturists in matters relating to this subject.

*Assignment.*—S. F. Blake.

*Proposed expenditures, 1918-19.*—No allotment; work incidental to other projects.

#### **Monograph of the Grossulariaceæ, with Special Reference to the Species Useful in the United States:**

*Object.*—To accurately classify American gooseberries and currants.

*Procedure.*—Living plants and herbarium material are collected and studied, with the view of securing suitable stocks for cultivation and for plant breeding.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—Work for the present is confined to the accumulation of data through the receipt and identification of specimens.

*Assignment.*—Frederick V. Coville.

*Proposed expenditures, 1918-19.*—No allotment; work incidental to other projects.

#### **Records of the Origin and Character of Varieties of Ornamental Plants Originating Under Cultivation:**

*Object.*—To secure uniformity of nomenclature and accuracy of description in trade catalogues.

*Procedure.*—An index is kept of the cultivated plants offered in nurserymen's and seedsmen's catalogues.

*Cooperation.*—Horticulturists.

*Location.*—Washington, D. C.

*Date begun.*—1908.

*Results.*—An index of varieties of plants is maintained, which is much used by various offices of the department and in answering inquiries of department correspondents.

*Assignment.*—S. F. Blake.

*Proposed expenditures, 1918-19.*—\$1,507.

**Miscellaneous Identifications:**

*Object.*—To identify plant material submitted by agricultural and horticultural workers and from various other sources.

*Cooperation.*—Forest Service, various State stations, and correspondents.

*Location.*—Washington, D. C.

*Date begun.*—1868.

*Results.*—During 1917, 3,629 miscellaneous identifications were made, a large proportion being for the Forest Service.

*Assignment.*—S. F. Blake, Ivar Tidestrom.

*Proposed expenditures, 1918-19.*—\$2,974.

**Total, Systematic Work in Economic Botany, \$7,400.**

**Total, Investigations in Economic and Systematic Botany, \$32,447, including \$9,347 statutory.**

[Research.]

**DRY-LAND AGRICULTURE INVESTIGATIONS.****Supervision:**

*Object.*—To supervise the maintenance of field stations and direct the agricultural work in dry-land areas of the Great Plains region, furnish facilities for investigational activities of other bureaus and offices of the department, and conduct the necessary routine work in connection with this work.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—E. C. Chilcott, agriculturist in charge; J. S. Cole, agriculturist; and J. M. Stephens, O. J. Grace, and E. F. Chilcott, group leaders.

*Proposed expenditures, 1918-19.*—\$27,680.

**Field Investigations:**

*Object.*—To determine the best methods of soil cultivation and crop rotations for the conservation of moisture and the maintenance of humus in the soil of the Great Plains area.

*Procedure.*—The agriculturist in charge and the agriculturist have general supervision and direction of all administrative and investigational work.

Nine fully equipped independent field stations are maintained by this office. Field operations are conducted cooperatively at 5 field stations operated by other offices of the Bureau of Plant Industry and at 10 substations maintained and operated by State experiment stations. For the purpose of supervision these 24 stations are divided into three groups. The northern group includes all stations in Montana, North Dakota, and South Dakota and the Sheridan field station in Wyoming and is under the group leadership of the superintendent of the Mandan (N. Dak.) field station. The central group includes the Archer field station, in Wyoming, and all stations in Nebraska, Kansas, and Colorado, and is under the group leadership of the superintendent of the Akron (Colo.) field station. The southern group includes all stations in Oklahoma, New Mexico, and Texas and is under the group leadership of the superintendent of the Woodward (Okla.) field station. These three group leaders keep in close touch with the investigations being conducted in their respective groups of stations, consult with other superintendents and assistants in immediate charge of these investigations concerning the correlation and development of the work at the several stations, and make recommendations to the agriculturist in charge as to the administrative and technical details requiring his attention during the growing season.

A superintendent is assigned to each of the 9 independent field stations. He has full charge of and is held responsible for all the details of the cooperative work between this office and various cooperating offices of the Bureau of Plant Industry and other bureaus. He provides facilities such as land, tools, common labor, teams, and office and laboratory space for the cooperating offices. He also either attends personally to the details of the investigational work, as outlined in the following paragraph, or supervises the work of an assistant in dry-land agriculture assigned to his station for this purpose.



At each of the 15 cooperative stations an assistant in dry-land agriculture is detailed during the growing season. He has full charge of and is held responsible for all the details of the dry-land agriculture investigations being carried on at the station. He attends personally, with such help from unskilled laborers as they can give, to the taking of soil samples and the making of moisture determinations and meteorological observations, and keeps records of the preparation, seeding, tillage, harvesting, thrashing, weighing, and measuring of all crops grown on dry-land plats. The superintendent of the cooperating station provides facilities such as necessary land for the experimental plats, tools, teams, common labor, and office and laboratory space for the work.

During the winter months the scientific force of the office is engaged at the Washington office in preparing notes of the season's work for permanent record or for publication. Complete records of all work are kept at both the field stations and at the Washington office, where they are open to the inspection of the public at all times. All cooperative agencies are also provided with copies of the record of their cooperative work.

The major problems involved in the development of dry-land agriculture in the Great Plains are regional rather than local in their nature. The investigations are, therefore, all planned in the Washington office and, so far as practicable, are replicated at all the field stations, only such modifications being made in these general plans as become necessary to meet local adaptation of crops to environment at the individual stations. These plans require the use of about 200 permanent plats and fields for the growth of crops, and the making of about 1,000 determinations of soil moisture at each station each year.

*Cooperation.*—See lists of stations, which follow.

*Location.*—See lists of stations, which follow.

*Date begun.*—See lists of stations, which follow.

*Results.*—This office is engaged in establishing the fundamental principles underlying the agricultural possibilities of an immense area of over 400,000 square miles, known as the Great Plains. The annual average precipitation of the region ranges from less than 15 inches in the northern and western portion to more than 25 inches in the southeastern portion of the area. The annual precipitation varies from year to year from as low as 7 inches to as high as 40 inches. The average seasonal evaporation varies from 18 inches to 41 inches. The average length of the growing season ranges from 100 to 194 days. The soils range from light sand to the heaviest clays. It is therefore obvious that the results of any one year at any one station can have but little value, except when considered in connection with the results from all the stations through a long series of years. It, therefore, seems better to avoid repetition and cite some of the more important results of the work as a whole than to attempt a detailed report under each station project. The best and most profitable methods of producing spring wheat, oats, corn, barley, kafir, milo, and winter wheat in each section of the Plains has been determined and published in Department Bulletins 214, 218, 219, 222, 242, 268, and 595, and Farmers' Bulletin 895. The largest net profits have usually been obtained from crops raised by cultural methods involving a low cost of production rather than from high yields obtained from methods involving a high cost of production. In other words, extensive rather than intensive systems of farming should be followed. From the results under known conditions in the past years the average results of a series of years in any section can now be foretold with a reasonable degree of certainty, but the effect of the season is so much greater than that of cultivation that nowhere in the Great Plains can the results of a single season be forecast.

It has been found that the relative value of early and late fall plowing and of spring plowing is determined by the amount and distribution of rain and snow before and after plowing. The subject is discussed in detail in Department Bulletin 253. By a long-continued series of experiments covering a wide range of soils, crops, and climatic conditions, it has been conclusively proven that subsoiling does not increase average yields and does not afford any protection against drought. Neither is amelioration of dry-farming conditions to be obtained through deep tilling with dynamite or special plows. These results are now in completed manuscript ready for publication.



Continuous, systematic determinations of soil moisture at 24 stations for an average of 7 years at each station has resulted in the accumulation of over 170,000 determinations. These are now being coordinated with climatic, soil, and cultural conditions and crop results. The studies to date show that neither the water-holding capacity of the soil nor the conservation of the soil water is materially dependent upon cultivation, except in so far as it prevents the growth of weeds; that the capillary movement of soil water is a negligible factor in the production of crops on the dry tablelands of the Great Plains; that each unit of depth of soil can retain a definite amount of water available to crop and that this amount is determined by the physical character of the soil; that it is impossible to retain water in the soil in excess of this amount; and that the storage of water in depths below those penetrated by roots is useless and wasteful.

From the information obtained in these investigations it is possible within certain limits to interpret soil and climatic conditions in terms of crop-production possibilities. This has been of great value in assisting the U. S. Geological Survey in the classification of lands under the act providing for 640-acre stock-raising homesteads.

Results of the work in their respective States have been published in 11 bulletins by cooperating State experiment stations.

At Ardmore, S. Dak., the establishment of the fact that cultural methods alone are not sufficient to overcome unfavorable conditions, but that a sound agriculture must be based on the growth of feed and the production of live stock, has resulted in the establishment of cooperative work with the Animal Husbandry and Dairy Divisions of the Bureau of Animal Industry, through which the methods of beef, pork, and dairy production in this section will be determined.

At the Mandan (N. Dak.) field station five years' results have been obtained in investigations of the methods of growth of garden vegetables. These results are now being prepared for publication. In horticultural investigations the results indicate that accepted methods must be radically changed to adapt them to the extreme conditions of the northern Great Plains. Testing and breeding to secure hardy horticultural plants is making satisfactory progress. Two severe winters in succession have forwarded this work by eliminating unadapted material. In shelter-belt work with farmers in the northern Great Plains active cooperation is now maintained with 507 farmers, who were furnished stock and planted shelter-belts in 1916, 201 who planted in 1917, and 392 who are applicants for future planting. In 1916, 701,911 and in 1917, 357,700 trees were sent out. In 1916 the percentage of growth was 80 per cent and in 1917 it was 81.2 per cent.

Over the Great Plains as a whole, 1917 was one of the driest and most unfavorable years that has been experienced since the work began. In the southern section of the Plains this season has demonstrated the value of sorghum crops, the value of preparation that stores soil water, and the inadvisability of early seeding under adverse conditions. In the central portion of the Plains valuable data on the preparation of land for winter wheat and other crops was obtained. In the northern portion the importance of a crop rotation that provides for a cultivated crop as preparation for a small grain was again demonstrated.

*Assignment.*—See lists of stations, which follow.

*Proposed expenditures, 1918-19.*—See lists of stations, which follow.



**(a) INVESTIGATIONS AT INDEPENDENT FIELD STATIONS OF THE OFFICE OF DRY-LAND AGRICULTURE.**

Location.	Cooperation. <sup>1</sup>	Date begun.	Assignment.	Proposed expenditures, 1918-19.
Akron, Colo.....	Commissioners of Washington County, Colo.; Colorado Experiment Station; A, B, C, D, F, I, K, L.	1907	O. J. Grace, J. F. Brandon.	\$7,000
Ardmore, S. Dak.....	A, B, D, G, H, L.....	1911	F. L. Kelso.....	12,000
Big Spring, Tex.....	A, B, C, D, E, K.....	1914	L. N. Jensen.....	7,000
Dalhart, Tex.....	A, B, C, D, F.....	1907	H. J. Clemmer.....	10,000
Lawton, Okla.....	A, B, C, D, E, K, N.....	1915	W. M. Osborn.....	7,100
Mandan, N. Dak.....	North Dakota Experiment Station; A, B, C, D, F, I, K, L, M.	1913	J. M. Stephens, J. T. Sarvis, M. Pfaender, F. E. Cobb, N. O. Henchel, R. S. Towle, R. Wilson.	31,200
Sheridan, Wyo.....	Wyoming Board of Farm Commissioners; Wyoming State Board of Land Commissioners; Wyoming Experiment Station; A, B, C, D, K, O.	1916	L. D. Willey.....	7,500
Tucumcari, N. Mex....	New Mexico Experiment Station; A, C, D, E, F, K.	1911	C. B. Brown.....	7,000
Woodward, Okla.....	Woodward County Commissioners; A, B, C, D, E, K, O.	1914	E. F. Chilcott.....	9,150
				97,950

**(b) INVESTIGATIONS AT STATIONS MAINTAINED BY OTHER OFFICES OF BUREAU OF PLANT INDUSTRY.**

Amarillo, Tex.....	Cereal Investigations; A, B.....	1906	J. E. Mundell.....	\$2,000
Archer, Wyo.....	Cereal Investigations; A, B.....	1913		2,000
Belle Fourche, S. Dak..	Western Irrigation Agriculture; A, B	1907	O. R. Mathews.....	2,690
Huntley, Mont.....	Western Irrigation Agriculture; A, B, G.	1909	A. E. Scamans.....	4,600
Scottsbluff, Nebr.....	Western Irrigation Agriculture; A, B	1909	A. Osenbrug.....	2,600
				13,890

**(c) INVESTIGATIONS IN COOPERATION WITH STATE STATIONS.**

Colby, Kans.....	Kansas Experiment Station; A, B...	1914	J. B. Kuska.....	\$1,800
Dickinson, N. Dak.....	North Dakota Experiment Station; A, B.	1906	J. C. Thysell.....	2,300
Edgeley, N. Dak.....	North Dakota Experiment Station; A, B	1906	O. A. Thompson.....	2,500
Havre, Mont.....	Montana Experiment Station; A, B, I.	1915	G. W. Morgan.....	2,750
Hays, Kans.....	Kansas Experiment Station; A, B..	1906	A. L. Hallsted.....	2,500
Hettinger, N. Dak.....	North Dakota Experiment Station; A, B.	1910		2,500
Garden City, Kans.....	Kansas Experiment Station; A, B..	1906	F. A. Wagner.....	2,300
Judith Basin, Mont....	Montana Experiment Station; A, B.	1907	P. V. Cardon, W. P. Baird.	4,350
North Platte, Nebr.....	Nebraska Experiment Station; A, B, I.	1906	L. L. Zook.....	3,100
Williston, N. Dak.....	North Dakota Experiment Station; A, B.	1908	C. H. Ruzicka.....	2,300
				26,400

<sup>1</sup> The letters in this column have the following meaning: A, Weather Bureau; B, Office of Biological Investigations; C, Office of Cereal Investigations; D, Office of Forage-Crop Investigations; E, Office of Crop-Acclimatization Investigations (cotton investigations); F, Forest Service; G, Division of Animal Husbandry, Bureau of Animal Industry; H, Dairy Division, Bureau of Animal Industry; I, Office of Drug-Plant and Poisonous-Plant Investigations; K, Office of Horticultural and Pomological Investigations; L, Office of Alkali and Drought Resistant Plant Investigations; M, Office of Foreign Seed and Plant Introduction; N, Office of Western Irrigation Agriculture Investigations; O, Office of Soil-Fertility Investigations.

**Total, Dry-Land Agriculture Investigations, \$165,920, including \$5,920 statutory.**

## [Research.]

## WESTERN IRRIGATION AGRICULTURE INVESTIGATIONS.

**Supervision:**

*Object.*—To maintain field stations and supervise agricultural work on irrigated and other lands in the arid and semiarid regions of the western United States and conduct routine office business in connection therewith.

*Procedure.*—Eight field stations are operated, each under the immediate supervision of a farm superintendent, who, with his assistants, attends to all the general and technical work, such as taking notes on the behavior of crops under different treatments, making moisture determinations, recording meteorological observations, the supervision of cultural and harvesting operations connected with the experimental work, recording all notes on operations, crop yields, labor cost, etc. The superintendent also provides facilities, such as land, teams, common labor, and office and laboratory supplies, for the use of cooperating offices of the bureau.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—C. S. Scofield.

*Proposed expenditures, 1918-19.*—\$13,320.

**Belle Fourche (S. Dak.) Field Station:**

*Object.*—To determine crop varieties and agricultural methods most suitable to successful farming on irrigated lands of the region.

*Procedure.*—Outlined under "Supervision." Cooperation is had with the Offices of Dry-Land Agriculture, Alkali and Drought Resistant Plant Investigations, Biophysical Investigations, Cereal Investigations, Sugar-Plant Investigations, and Corn Investigations, all of this bureau.

*Cooperation.*—Forest Service.

*Location.*—Near Newell, S. Dak.

*Date begun.*—1907.

*Results.*—The past season was favorable and decisive results were secured from the field experiments. The cooperative work was extended to include additional experiments with hogs on alfalfa pasture and dairy stock on mixed-grass pastures. The pasturing of sheep on alfalfa was continued. Extensive cooperative experiments in cereal production were continued. The experiments in irrigated-crop rotations were continued and somewhat extended. A varietal test of silage crops was conducted, including sunflowers, which yielded twice as much as the average of the corn varieties.

*Assignment.*—Beyer Aune.

*Proposed expenditures, 1918-19.*—\$12,000.

**Huntley (Mont.) Field Station:**

*Object.*—To determine crop varieties and agricultural methods most suitable to successful farming on the Huntley Reclamation Project.

*Procedure.*—Outlined under "Supervision." Cooperation is had with the Offices of Demonstrations on Reclamation Projects, Dry-Land Agriculture, Corn Investigations, Forage-Crop Investigations, Sugar-Plant Investigations, and Biophysical Investigations, all of this bureau.

*Cooperation.*—Montana Experiment Station and Bureau Animal Industry.

*Location.*—Near Huntley, Mont.

*Date begun.*—1909.

*Results.*—A very favorable season prevailed during last year and consequently good results were secured from the field experiments. The cooperative work was materially increased through an additional appropriation for live-stock experiments from the Montana Experiment Station, through an extension of the water-requirement work of the Biophysical Laboratory, and through the addition of experiments in the production of hogs and dairy cattle under the supervision of the Bureau of Animal Industry. Several additional buildings were constructed. Additional land was also secured for experiments with irrigated crops.

*Assignment.*—Dan Hansen, E. G. Noble.

*Proposed expenditures, 1918-19.*—\$11,280.



**Lawton (Okla.) Field Station:**

*Object.*—To inaugurate and supervise experiments with irrigated crops on the experiment farm maintained at Lawton, Okla., by the Office of Dry-Land Agriculture, for the purpose of determining crop varieties and agricultural methods best suited to successful agriculture on the irrigated lands of the region.

*Procedure.*—It is proposed to station a field representative at the Lawton station who will attend to the general and technical work of these irrigation experiments, such as the taking of notes on the behavior of different crops under various treatments, making moisture determinations, supervising the cultural and harvesting operations connected with the work, recording all notes on operations, crop yields, labor costs, etc. This work will be conducted in cooperation with the Office of Dry-Land Agriculture of this bureau.

*Location.*—Near Lawton, Okla.

*Date begun.*—1916.

*Results.*—No progress has been made during the year because of the absence of a supply of irrigation water.

*Assignment.*—Leader to be appointed.

*Proposed expenditures, 1918-19.*—\$5,000.

**San Antonio (Tex.) Field Station:**

*Object.*—To determine new and standard crops and agricultural methods adapted to successful farming in the vicinity of San Antonio, Tex.

*Procedure.*—Detailed under "Supervision." Cooperation is had with the following offices of the Bureau of Plant Industry: Crop-Acclimatization Investigations, Alkali and Drought Resistant Plant Investigations, Biophysical Investigations, Corn Investigations, and Seed and Plant Introduction.

*Location.*—Near San Antonio, Tex.

*Date begun.*—1903.

*Results.*—During the past year another season of adverse climatic conditions was experienced, drought and cold weather being the chief adverse factors. Experiments in the control of cotton root-rot were continued, but without conclusive results. A variety test of cotton showed the superiority of the Acala variety. The rotation and tillage experiments were continued and gave additional confirmatory results. Experiments with various methods of planting and thinning cotton were continued on a large scale. Further demonstrations of methods of producing grain sorghums were carried on.

*Assignment.*—C. R. Letteer, A. A. Bryan.

*Proposed expenditures, 1918-19.*—\$10,000.

**Scottsbluff (Nebr.) Field Station:**

*Object.*—To determine crop varieties and agricultural methods most suitable to successful agriculture on the irrigated lands of the region.

*Procedure.*—Detailed under "Supervision." Cooperation is had with the Offices of Demonstrations on Reclamation Projects, Cereal Investigations, Biophysical Investigations, Horticultural Investigations, Dry-Land Agriculture, and Corn Investigations of this bureau.

*Cooperation.*—Nebraska Experiment Station.

*Location.*—Near Mitchell, Nebr.

*Date begun.*—1909.

*Results.*—Climatic conditions were more favorable than during the previous two seasons and better results were secured from the field experiments. The variety tests were restricted to fewer varieties. Several of the experiments in cultural methods were concluded. The demonstrations of methods of pasturing hogs on alfalfa were continued and a preference test of alfalfa varieties for hog pasturing begun. The experiment in irrigated-crop rotations was completed for the sixth year and striking results in the use of manure and of the stimulating effect of alfalfa in crop rotations shown. A comparative test of varieties of corn for silage and of sunflowers for the same purpose was conducted and showed that sunflowers yield about twice as much forage as corn. The cooperative work was continued, including experiments with dairy stock and in lamb feeding.

*Assignment.*—James A. Holden, David W. Jones, jr.

*Proposed expenditure, 1918-19.*—\$7,900.



**Truckee-Carson (Nev.) Field Station:**

*Object.*—To determine crop varieties and agricultural methods most suitable to successful farming on the Truckee-Carson Reclamation Project.

*Procedure.*—Outlined under "Supervision." Cooperation is had with the Offices of Biophysical Investigations and Demonstrations on Reclamation Projects of this bureau.

*Location.*—Near Fallon, Nev.

*Date begun.*—1906.

*Results.*—The cooperative experimental work with farmers on the project was continued with satisfactory results. On the experiment farm a rotation experiment was begun, and the experiments in the improvement of alkali lands was continued. Varietal and cultural experiments with the more important truck crops were repeated. Laboratory experiments with alkali soils were continued and current results published. Demonstrations of pasturing hogs and dairy cows on alfalfa and sweet clover were conducted and a number of pasture grasses tried, with good results.

*Assignment.*—F. B. Headley.

*Proposed expenditures, 1918-19.*—\$10,000.

**Umatilla (Oreg.) Field Station:**

*Object.*—To determine crops and agricultural methods best adapted to successful farming on the sandy soils of the Umatilla Reclamation Project.

*Procedure.*—Outlined under "Supervision." Cooperation is had with the Offices of Horticultural Investigations, Cotton, Truck, and Forage Crop Disease Investigations, Sugar-Plant Investigations, and Demonstrations on Reclamation Projects, all of this bureau.

*Cooperation.*—Forest Service and Oregon Experiment Station.

*Location.*—Near Hermiston, Oreg.

*Date begun.*—1909.

*Results.*—Continued special attention was given during the past year to methods of irrigation applicable to sandy soils and to increasing the supply of organic matter in the soil. Four additional lysimeters were installed and the investigations concerning the percolation of irrigation water correspondingly increased. A series of rotation experiments, aimed chiefly to determine the most efficient use of farm manure, were continued, and a system of overhead irrigation was installed. Tests of varieties of forage and grain crops were continued, and additional information was secured relative to the behavior of varieties of orchard fruits.

*Assignment.*—H. K. Dean.

*Proposed expenditures, 1918-19.*—\$3,000.

**Yuma (Ariz.) Field Station:**

*Object.*—To develop agricultural methods under irrigation.

*Procedure.*—Outlined under "Supervision." Cooperation is had with the following offices of the Bureau of Plant Industry: Crop-Acclimatization Investigations, Paper-Plant Investigations, Alkali and Drought Resistant Plant Investigations, Biophysical Investigations, and Crop Physiology and Breeding Investigations.

*Location.*—Bard, Cal.

*Date begun.*—1906.

*Results.*—During the past year additional land was made available for experimental work through leveling, and the land previously leveled, which had shown unevenness, was much improved by plowing under green-manure crops. Pasturing alfalfa with hogs was continued, with satisfactory results. The varieties of fruit in the deciduous-fruit orchard gave additional definite results. Comparative tests of Upland long-staple and two varieties of Egyptian cotton were made, showing that relatively high yields can be secured from the new Pima variety of Egyptian cotton. The furrow-and-bed method of cotton production gave better results than the ordinary method of flat planting. The new Indian variety of alfalfa gave further evidence of its suitability to local conditions.

*Assignment.*—R. E. Blair, C. E. Peterson.

*Proposed expenditures, 1918-19.*—\$12,000.

**(Introduction of Commercial Cotton Culture in the Southwest:** The commercial establishment of long-staple cotton in the arid Southwest is practically completed. Something over 40,000 acres were devoted to this crop



in 1917 in the irrigated valleys of this region. Good yields were secured, and very high prices prevailed throughout the season. Further work along this line will be carried on incidental to other projects and without expense to this office.)

**Total, Western Irrigation Agriculture Investigations, \$84,500, including \$10,920 statutory.**

## POMOLOGICAL INVESTIGATIONS.

### SUPERVISION.

#### Supervision:

*Object.*—To provide supervision of the research work and the necessary clerical assistance for its handling and for correspondence, maintenance of records, and other activities connected therewith.

*Location.*—Washington, D. C.

*Date begun.*—1886.

*Assignment.*—L. C. Corbett, H. P. Gould.

*Proposed expenditures, 1918-19.*—\$16,160, including \$9,670 statutory (research).

[Research.]

### FRUIT-STORAGE INVESTIGATIONS.

#### Fruit Harvesting, Handling, Transportation, and Storage, in Cooperation with the Bureau of Markets:

*Object.*—To determine the effect on the physical well-being and keeping qualities of merchantable fruits of various methods of handling at picking time and in packing, transporting, storing, and marketing fruits; of picking devices and picking receptacles; of methods of sizing, wrapping, packing, and character of container; and of methods of stowing in cars and in storage, both common and refrigerated.

*Procedure.*—The various lots of fruits of the same variety having like developmental history are picked in various receptacles, sized on different types of sizers, wrapped in different types of wrapping material, stored in containers of various character, stowed in different ways, and held at various temperatures, in order to determine the effects of these various processes in the commercial handling of fruits from the field to the market, and to ascertain which, if any, react detrimentally upon the well-being of the fruit itself when considered from the standpoint of a living organism.

*Cooperation.*—Bureau of Markets, Bureau of Chemistry, and fruit growers.

*Location.*—Field work in various important fruit-growing regions, including Washington, Oregon, California, Colorado, Idaho, Virginia, and New York.

*Date begun.*—1901; cooperation with Bureau of Markets, 1918.

*Results.*—Improved methods of handling fruits, particularly citrus fruits, grapes, prunes, apples, pineapples, and strawberries have been developed and losses resulting from improper methods of picking and handling reduced, insuring better physical condition on arrival at markets. Improved modifications to methods of stowing in transit have been worked out. The effectiveness of precooling to increase the carrying capacity of perishable fruits, as well as ability to deliver in a sound and satisfactory condition fruits of a more advanced stage of maturity than was possible without precooling, has been demonstrated. Important evidence has been secured which indicates the need of improved modifications in the equipment of carriers to insure more uniform cooling of the product in transit. In fact, the studies of the behavior of perishable fruits in transit has developed the fact that increased tonnage can be safely transported in the same conveyances by modifying methods of stowing and by improving the equipment of the carriers as regards bunkers and false floors, thus increasing the carrying capacity of the available refrigerator equipment. These modifications in the construction of the carrier insure quicker cooling to the load and consequently increased insurance to the load while in transit.

*Assignment.*—Lon A. Hawkins.

*Proposed expenditures, 1918-19.*—\$5,000.



**Factors Affecting the Storage Life of Fruit:**

*Object.*—To determine the effects and relative importance of different environmental and physical factors, including methods of cultivation, fertilization, spraying, and other orchard treatments, geographical location, handling, and degree of maturity when picked on the storage life of fruits.

*Procedure.*—Factors affecting life processes of fruits are analyzed and physiological studies made of various kinds of fruits under different conditions of temperature, moisture, and aeration to determine the combination of environmental factors which will prolong the life of fruit in common and cold storage to the maximum. The requirements of different kinds of fruits are known to vary, and these investigations are for the purpose of accurately determining the range of environmental conditions which can be endured by these organisms without detriment to their physical condition or commercial value. These investigations are so planned as to determine the causes of loss in quality, of scalding in storage, of internal browning, and of other forms of breaking down in storage independent of microorganisms.

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Results.*—Physiological studies on the storage of apples, pears, and grapefruit are under way and have yielded some interesting results. No publications have been made as yet.

*Assignment.*—Lon A. Hawkins, H. R. Kraybill, C. E. Sando.

*Proposed expenditures, 1918-19.*—\$6,200.

**Total, Fruit-Storage Investigations, \$11,200, including \$1,200 statutory.**

**VITICULTURAL INVESTIGATIONS.****Vinifera Grapes:**

*Object.*—To determine the relative adaptability of resistant grape stocks, direct producers, and Vinifera grape varieties to soil types and climatic and other environmental conditions; to study the relative congeniality of grape varieties to different resistant stocks; to investigate the adaptability of the Vinifera to soil types and climatic and other conditions in regions not infested with phylloxera; when necessary, to develop resistant direct producers valuable for the several purposes and suited to the different conditions in this country; to determine the uses of grape varieties; to find the best methods of propagating, grafting, planting, cultivating, pruning, and training grapes in different environments, and to discover, develop, and disseminate valuable varieties.

*Procedure.*—Studies are made of resistant stocks, direct producers, Vinifera and other Euvitis, and Euvitis grafted on resistant stocks now planted under a wide range of soil, climatic, and other conditions in experiment and commercial vineyards. Studies are made of the relative value of grape varieties for the different uses, their relative adaptability, vigor of growth, and ability to endure and resist drought, alkali, etc., as well as phylloxera and the various vine diseases. Special investigations of various viticultural problems presenting themselves are pursued in the department's experiment vineyards.

*Cooperation.*—Vineyardists and vineyard companies in California.

*Location.*—Washington, D. C., and cooperative experiment vineyards located at Colfax, Chico, Elk Grove, Fresno, Geyserville, Guasti, Lodi, Oakville, Sonoma, and Stockton, Cal.

*Date begun.*—1903.

*Results.*—The duplicate variety collections used upon resistant stocks in the several experiment vineyards are clearly demonstrating the sorts which are most advantageous for stocks under the altitudes, climatic and other conditions, and the soil types found in the department's different experiment vineyards. Extensive tests on a range of resistant-stock varieties of Euvitis varieties commercially grown in this country, as well as of a large number of varieties introduced by the department and previously not grown or known in this country, are definitely demonstrating the combinations of stocks and varieties best adapted for commercial planting for different purposes and for the various vineyard regions. Through these tests the superior values and uses in commercial vineyards of a number of grape varieties heretofore not grown in this country have



been demonstrated and other promising varieties are under observation. The testing of currant-producing varieties and the Almerian storage and shipping varieties have given encouraging results. These have been supplemented by pruning and training experiments which are fundamental in their importance. Incision experiments are also under way, and plantings of the grapes have been made in cooperation with growers to demonstrate their value in this country on a commercial basis. While climatic conditions were very trying last season, some valuable results were secured in relation to the resistance of certain varieties to adverse conditions. An additional collection of 33 direct-producing grape varieties were added to the tests in the experiment vineyards. Clusters of 74 varieties were sent from the department's experiment vineyard at Guasti, Cal., to the Dry-Land Congress at El Paso, Tex.

Results to 1909 were published in Bureau of Plant Industry Bulletin 172; results since that time to 1915 in Department Bulletin 209; data also in Department Bulletin 349, "The Raisin Industry of the United States."

*Assignment.*—George C. Husmann, Fred L. Husmann, Elmer Snyder.

*Proposed expenditures, 1918-19.*—\$8,050.

### **Muscadine or Rotundifolia Grapes:**

*Object.*—To investigate methods of propagating, grafting, planting, pruning, spraying, cultivating, fertilizing, and growing Muscadine grapes; to determine the range and adaptability of known varieties; to originate and develop better Muscadine varieties and hybrids of them and other species with large clusters and better adherence of berry to pedicle, of higher sugar and lower acid content, and with perfect self-fertile flowers, etc.; and to determine best methods of harvesting, handling, and utilizing the fruit.

*Procedure.*—Field studies of vineyards and vines throughout the Muscadine regions are made. All promising varieties are assembled into a comprehensive collection for observation and testing to determine their relative values. Tests in the experiment vineyard and in commercial vineyards are conducted to ascertain the best methods of trellising, pruning, training, spraying, pollenizing, cultivating, fertilizing, and growing Muscadine grapes. Breeding investigations are conducted in the experiment vineyard.

*Cooperation.*—North Carolina Department of Agriculture and private individuals.

*Location.*—Washington, D. C., Willard, N. C., and commercial vineyards throughout Muscadine regions.

*Date begun.*—1905.

*Results.*—It has been demonstrated that the commercial Muscadine varieties are practically self-sterile, that insects are the chief agencies of cross-pollination, and that interplanting of male vines is necessary. The breeding work has developed many desirable types, including self-fertile forms and hybrids with *Vinifera* and American *Euveitis* species. Several thousand seedlings have been produced and are under test. It has been demonstrated that pruning is necessary for best fruiting results and that good results can be obtained by growing Muscadines on a vertical trellis. General progress has been made along other lines. A collection of Muscadine grape products, including jellies, jams, and marmalades, was made at the Pender (N. C.) Test Farm and exhibited at the Wilmington (N. C.) Corn Show. The same products were displayed also before the State agents in home-demonstration work in the South at a conference held in Washington, D. C., in December, 1916. Results to 1911 are published in Bureau of Plant Industry Bulletin 273; data also contained in Farmers' Bulletins—709, "The Muscadine Grapes," and 758, "Muscadine Grape Sirup." Special attention has been given to the home utilization of this class of grapes, and as a result a variety of useful and appetizing products has been produced, including jams, jellies, preserves, and unfermented juices. Unfermented juice of special merit, prepared in conformity with directions worked out by this office, has been produced from grapes of the James variety.

*Assignment.*—Charles Dearing.

*Proposed expenditures, 1918-19.*—\$3,000.



**American Euvitis:**

*Object.*—To investigate the relative adaptability of native American grapes and their hybrids to the soil and climatic conditions of the various grape-growing regions of the United States; to determine the value and uses of the several species and their hybrids in these regions; to ascertain the best methods of propagating, grafting, pruning, training, fertilizing, cultivating, and growing them; to develop and disseminate new and improved varieties; and to assist in reestablishing grape culture on a sound and rational basis.

*Procedure.*—This project involves field studies of the adaptability to soils, climates, and other conditions of native American grapes; studies of resistance to alkali, drought, moisture, heat, cold, diseases, insects, etc.; and researches to determine the value and uses of American Euvitis, their hybrids, and other species in commercial and experiment vineyards. Particular attention is given to methods of pruning, training, fertilizing, and culture.

*Cooperation.*—Vineyardists and vineyard companies in California and New Jersey.

*Location.*—Washington, D. C., Vineland, N. J., and Chico, Colfax, Fresno, Geyserville, Guasti, Oakville, and Sonoma, Cal.

*Results.*—Descriptions and illustrations have been made of a number of American grape varieties, and their value for dessert purposes and for the manufacture of unfermented juice determined. Valuable results are being obtained from tests of different methods of pruning, training, and fertilizing. Material for propagation of a number of rare, almost extinct, varieties was received from various sources. The plantings made in the varietal collection vineyard at the Arlington Farm now represent 190 grape varieties. Arrangements have been made with the Training School at Vineland, N. J., for the continuation of the department's experiment vineyard at that place. Publications of results have appeared in the Department Yearbook for 1904, "Some Uses of the Grapevine and Its Fruit"; Farmers' Bulletin 644, "Manufacture and Use of Unfermented Grape Juice"; and Farmers' Bulletin 471, "Grape Propagation, Pruning, and Training." A bulletin on American Euvitis has been submitted for publication.

*Assignment.*—George C. Husmann, Fred L. Husmann.

*Proposed expenditures, 1918-19.*—\$5,850.

**Total, Viticultural Investigations, \$16,900, including \$900 statutory.**

**FRUIT-PRODUCTION INVESTIGATIONS.****Fruit Production and Adaptation:**

*Object.*—To determine by field surveys and experiments the most favorable cultural factors in the production of deciduous and subtropical fruits in the several recognized, as well as prospective, fruit regions of the United States; and to secure information concerning the behavior of fruit varieties when grown under the different climatic and other environmental conditions peculiar to these regions.

*Procedure.*—There are three main features in this investigation: (a) Propagation of fruits and nursery practices; (b) cultural methods and orchard technique; and (c) adaptability of varieties to environment, their suitability for specific purposes, and the geography of fruit growing. Because of the intimate relationships of these three factors of fruit production the work is prosecuted simultaneously.

Under (a) observations and experiments are made to determine the relative merits of different stocks congenial to the various producing areas. Histological studies of graft and bud unions are to be undertaken and a general study also made of the nursery practices followed in the commercial multiplication of the various fruits. Under (b) the details of the methods practiced by successful fruit growers operating under various conditions throughout the country are carefully observed and the results made available for those who may be able to profit thereby. Under (c) the influence of environmental conditions upon the behavior of varieties in different sections is studied for the purpose of determining the range of adaptability of the different sorts and ascertaining those best suited for particular uses in a given



locality. The geographic distribution of fruit growing, the factors which govern it, and the possibilities of extending commercial fruit growing in various localities are also given attention. Fruit plantations are maintained at the dry-land agriculture field station at Akron, Colo., and at the cereal field station at Amarillo, Tex.

*Location.*—Washington, D. C., Akron, Colo., Amarillo, Tex., and generally throughout the United States.

*Date begun.*—Some phases have been in progress since the organization of the Division of Pomology in 1886. The others have been taken up as conditions have made possible or the interests of the fruit industry have required.

*Results.*—Since the organization of the work on a project basis much information has been accumulated. This is constantly drawn upon in answering a very large and ever-increasing volume of correspondence about fruit-production matters. The phenological data that have been assembled through the cooperation of fruit growers are frequently consulted by other offices and bureaus of the department and occasionally by experiment stations.

Experiments have been started in Florida with pineapples in the selection of suckers for propagation and in cultural methods with a view to improve the yield and uniformity of the product. Special attention has been given to avocados because of the rapidly increasing interest in this fruit from a commercial standpoint and in order that the department may be in a position to give constructive assistance in a wise development of the industry. The most important activities have been in determining the best varieties and in locating the most desirable trees from which to propagate. Work along these lines has been carried on in Florida and California. The lime industry in Florida and the olive industry in California have also been studied.

The publications issued include five Bureau of Plant Industry bulletins, one Bureau of Plant Industry circular, about 25 Farmers' Bulletins, and some 14 or more papers in the Department Yearbooks. Manuscripts for two Farmers' Bulletins have been submitted, three are nearly ready for submittal, and four more are definitely projected or in course of preparation. Data are on file or in course of preparation for three Department Bulletins.

*Assignment.*—H. P. Gould, L. B. Scott, C. F. Kinman, W. F. Wight.

*Proposed expenditures, 1918-19.*—\$21,170, including \$1,920 statutory.

#### NUT-CULTURE INVESTIGATIONS.

##### Nut Culture:

*Object.*—To determine the range of adaptability of different nuts, the relative value and merit of different varieties, and their cultural requirements, including methods of propagation; to produce improved varieties; to discover uses for nut material which is now largely wasted; to determine through experimental means a combination of environmental factors which most closely approach the optimum for various types of nuts.

*Procedure.*—Data are being collected by personal visits to the principal points east of the Rocky Mountains where nuts are being grown and by correspondence with growers relating to the various phases of the nut industry. Records are kept of individual tree production in certain pecan orchards in Georgia and in Mississippi in order to locate high-yielding and regular-bearing trees, with a view to use them as parent trees from which to propagate, in the belief that by so doing orchard yields can eventually be materially increased. The leading varieties of pecans are being crossed with each other, and promising seedling nuts of various species are being observed in the hope of securing varieties superior to those now grown. Cultural methods and requirements of different nuts are being given special study by means of field plots designed to determine the fertilizer and water requirements of nut trees.

*Cooperation.*—National Nut Growers' Association, Northern Nut Growers' Association, and nut growers and dealers throughout the United States.

*Location.*—Washington, D. C., and nut-growing sections throughout the country.

*Date begun.*—About 1890.



*Results.*—Information has been obtained in regard to the relative crop capacity of various sorts of pecans in various geographical areas. Studies have been made or are under way to determine the relative performance of different trees of the same variety under like and under varying environments. The methods of nursery practice as regards propagation have been investigated, as well as pruning and top-working of more mature trees. Methods of sizing and grading nuts have been worked out and adopted as standards by the industry.

*Assignment.*—C. A. Reed.

*Proposed expenditures, 1918-19.*—\$10,200, including \$1,200 statutory.

#### **FRUIT IMPROVEMENT THROUGH BREEDING, SELECTION, AND DOMESTICATION.**

##### **Fruit Improvement Through Bud Selection:**

*Object.*—To improve, through bud selection based on individual tree performance records, standard varieties of both citrus and deciduous fruits, special attention being given to oranges, lemons, and pomelos among the citrus, and apples, peaches, and pears among the deciduous; to investigate bud variability of standard citrus and deciduous fruits; to develop and introduce reliable practical methods for the selection of desirable parent trees for propagation purposes; to determine the various strains in standard varieties of citrus and deciduous fruits; and to standardize the quality and quantity of the product of the best strains by means of bud selection based on accurate individual tree performance records and observations.

*Procedure.*—Individual tree performance records are being made in a large number of citrus and deciduous fruit orchards in California, Michigan, and Connecticut, from which the relative value of the different strains of the varieties under investigations are being determined. The most valuable trees of the best strains are used as sources of budwood, and progeny tests of these select trees are being made on an extensive scale. Through these progeny tests reliable sources of budwood of desirable strains are established.

*Cooperation.*—Citrus Experiment Station of the University of California, Michigan Experiment Station, and citrus and deciduous fruit growers.

*Location.*—Riverside, Cal., East Lansing, Mich., and South Glastonbury, Conn.

*Date begun.*—1910.

*Results.*—The first information regarding the value and importance of strains in citrus and deciduous fruit varieties was given the industry through the individual tree performance records. Commercial methods of keeping individual tree performance records have been worked out and are being extensively used by citrus and deciduous fruit growers to determine the inferior or drone trees in their orchards and to locate individual trees of special merit for sources of budwood. Data in Farmers' Bulletin 794, "Citrus Fruit Improvement: How to Secure and Use Tree Performance Records," and Bureau of Plant Industry Circular 77.

Bulletins giving the results of investigations for the improvement of the Washington Navel orange and of the Valencia orange are nearing completion. Results of investigations for the improvement of the Marsh pomelo are ready for submittal, and material relating to the improvement of the Eureka and Lisbon lemons and the Dancy tangerine will be available for publication in the near future.

*Assignment.*—A. D. Shamel, C. S. Pomeroy, C. L. Dyer.

*Proposed expenditures, 1918-19.*—\$9,710.

##### **Rosaceous-Fruit Breeding and Domestication:**

*Object.*—To study the fundamental principles involved in the breeding of new and improved varieties of rosaceous fruits, and to produce varieties of improved intrinsic quality, hardiness, productiveness, and disease resistance for the different fruit-producing regions of the country.

*Procedure.*—Crosses and selections are made of the most promising types of fruits in the several fruit-producing regions for the express purpose of securing, if possible, varieties capable of enduring or overcoming certain extreme conditions existing in these fruit regions or for the purpose of producing fruits which shall ripen at a period better to meet the needs of the market's supply from these regions.



*Cooperation.*—Texas, Maryland, and Michigan experiment stations, and private individuals.

*Location.*—Arlington Farm, Va., Troup, Tex., South Haven, Mich., Storrs, Conn., and College Park, Md.

*Date begun.*—1913.

*Results.*—A large number of varieties of peaches and plums in Texas, pears in Michigan, and apples in Maryland have been pollinated and many promising seedlings secured. Collections of seeds and seedlings have been secured from various parts of the world and are being grown under conditions which will demonstrate their value for use in connection with American fruit growing. This is especially true of peaches from the Orient and South America.

*Assignment.*—W. F. Wight, C. P. Close.

*Proposed expenditures, 1918-19.*—\$2,190.

**Total, Fruit Improvement Through Breeding, Selection, and Domestication,**  
\$11,900, including \$1,200 statutory.

#### INVESTIGATIONS IN SYSTEMATIC POMOLOGY.

##### Fruit History and Classification:

*Object.*—To classify the varieties of fruits into groups based on their genetic relationship; to accumulate data relative to the locality, manner of origin, and parentage of the varieties; to study the variation that occurs in each variety; and to prepare descriptions from original or other authentic material of varieties now in cultivation.

*Procedure.*—Data concerning the origin of varieties are obtained by correspondence and by reference to various published sources of information. Material of each variety is secured from the original tree or from other authentic source when the original tree is no longer available, carefully studied, and a description (with necessary illustrative material) prepared representing the type for a given variety. Additional authentic material is also studied in detail to establish the variation from the type that may occur in a variety, and a classification is being prepared, based on relationships as determined either by known parentage or as shown by such characters as are found to be constant and which are known from investigation to indicate relationship.

*Cooperation.*—State experiment stations, and private growers in various parts of the United States.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—A large amount of information concerning the origin of varieties has been brought together, important characters discovered enabling varieties hitherto frequently confused to be distinguished, and many detailed descriptions prepared, together with paintings and models of type material, as well as of varieties under varying soil and climatic conditions.

*Assignment.*—W. F. Wight, C. H. Farr, Lois M. Clency, Magdalene R. Newman.

*Proposed expenditures, 1918-19.*—\$11,180.

##### Fruit Nomenclature:

*Object.*—To secure the application of correct names to the different varieties of cultivated fruits, and to assist nurserymen, orchardists, and others interested by furnishing information concerning varietal nomenclature and description.

*Procedure.*—Data are secured through correspondence with nurserymen and commercial and amateur fruit growers, by reference to current and standard literature, and by verification of varieties in trial grounds at the Arlington Farm and elsewhere throughout the United States.

*Cooperation.*—American Pomological Society, American Association of Nurserymen, and various State horticultural and pomological societies.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1901.

*Results.*—Publications have been issued as follows: Bureau of Plant Industry Bulletins—56, "Nomenclature of the Apple," and 126, "Nomenclature of the Pear"; and various contributions to proceedings of societies. An increased public interest has been aroused in the simplification



of varietal names of fruits and in securing uniformity of usage; a willingness has been manifested on the part of nurserymen to adopt the characterization of varieties suggested by the department, and a marked decrease in the practice of introducing old varieties under new names has resulted.

*Assignment.*—W. F. Wight, E. R. Lake.

*Proposed expenditures, 1918-19.*—\$1,300.

#### **Fruit Identification:**

*Object.*—To determine the names of specimens of fruit not recognized by the growers or others concerned in the fruit industry and which have been submitted for this purpose.

*Procedure.*—Specimens submitted are studied and comparison made with original or other authentic descriptions and with illustrations in the department files.

*Location.*—Washington, D. C.

*Date begun.*—About 1886.

*Results.*—Many specimens of fruits have been submitted by growers and others and their identity determined so far as possible and reported to the senders.

*Assignment.*—C. P. Close.

*Proposed expenditures, 1918-19.*—\$920.

**Total, Investigations in Systematic Pomology, \$13,400, including \$5,400 statutory.**

#### **FRUIT-UTILIZATION INVESTIGATIONS.**

#### **Fruit Utilization:**

*Object.*—To secure information relative to the best and most practical methods of using fruits specially produced for the purpose or those classed as "get away" or surplus stock which can not be disposed of profitably in a fresh state.

*Procedure.*—Methods of desiccation, canning, and preserving fruits are being studied with the idea of developing practices adapted to the needs of the individual fruit grower so situated as not to be able to take advantage of the markets offered by the commercial industry, in order that a large and valuable product now largely lost because of the lack of simple and inexpensive methods of quick conservation may be made suitable for home and commercial use.

*Cooperation.*—Bureau of Chemistry, States Relations Service, and growers and home makers.

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—Information is now available on the drying of Logan blackberries (Loganberries), red and black raspberries, prunes, peaches, apricots, figs, and apples; on the behavior in drying and yields of dried product from the principal commercial varieties of apples; utilization for various purposes of evaporator waste in the form of jelly, jam, vinegar stock, etc., together with the methods of using such materials for these purposes as well as in the manufacture of animal foods; in regard to methods of packing and storing various dried fruit products; cost of construction and operation of various types of evaporators; standardized plans of evaporating installations of various sizes and types.

Careful experimentation has been carried on to determine the part which organic acids play in sterilization processes, and valuable data have been obtained.

Publications: Farmers' Bulletins—213, "Raspberries"; 291, "Evaporation of Apples"; 664, "Manufacture and Use of Unfermented Grape Juice"; 758, "Muscadine Grape Sirup"; 859, "Home Uses of Muscadine Grapes"; and 903, "Commercial Evaporation and Drying of Fruits." A manuscript has been submitted on "Home and Farm Drying of Fruits and Vegetables," and three manuscripts which contain information on fruit utilization are being prepared, namely, "Currants and Gooseberries," "Strawberry Culture in the Eastern United States," and "Fig Growing in the South Atlantic and Gulf States."

*Assignment.*—J. S. Caldwell, C. A. Magoon.

*Proposed expenditures, 1918-19.*—\$4,000.

See also Supplement—Emergency Activities, p. 566.)



## [Extension.]

## EXTENSION WORK IN HORTICULTURE.

**Extension Work in Horticulture:**

*Object.*—To study the methods of horticultural extension in effect in the various States, both North and South; to carry to each State the best available information regarding extension methods and cultural practices in other States; to aid in the dissemination of knowledge concerning the best horticultural and pomological practices as it is accumulated by the various commercial and investigational activities; to advise with the States Relations Service regarding technical horticultural methods and practices, including both fruits and vegetables.

*Procedure.*—The horticultural advisor keeps in touch with the horticultural work in each State through personal visits, correspondence, and in other ways; advises with those in charge of extension work in horticulture in the different States in regard to increasing the effectiveness of the work and improving methods; prepares for publication manuscripts on subjects of importance in the extension service and arranges with the proper State authorities for meetings and campaigns where special objects need to be attained or important information disseminated.

*Cooperation.*—States Relations Service and extension departments of the various State colleges and universities.

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Results.*—Organization of work in progress; two circulars on gardening published.

*Assignment.*—C. P. Close, Northern and Western States; H. C. Thompson, Southern States.

*Proposed expenditures, 1918-19.*—\$1,840.

(See also Supplement—Emergency Activities, p. 558.)

**Total, Pomological Investigations,** \$106,770, including \$21,490 statutory (research, \$104,930; extension, \$1,840).

## [Research.]

## HORTICULTURAL INVESTIGATIONS.

## SUPERVISION.

**Supervision:**

*Object.*—To provide supervision of research work and the necessary clerical assistance for the handling of correspondence, records, and other activities connected therewith.

*Location.*—Washington, D. C.

*Date begun.*—1900.

*Assignment.*—L. C. Corbett, H. P. Gould.

*Proposed expenditures, 1918-19.*—\$9,780, including \$5,513 statutory.

## VEGETABLE-STORAGE INVESTIGATIONS.

**Vegetable Harvesting, Handling, Transportation, and Storage, in Cooperation with the Bureau of Markets:**

*Object.*—To determine the effects of various methods of handling vegetables during harvesting, packing, transporting, storing, and marketing; of different harvesting devices and receptacles; of sizing; of stowing in cars and in storage warehouses (both common and refrigerated); and the relation of these methods and practices to the keeping qualities of merchantable vegetables.

*Procedure.*—Various lots of vegetables of the same variety having like developmental history are harvested and packed in receptacles of different sizes and types, stowed in cars and in storage houses in different ways, and held at different temperatures, in order to determine the effects of these various processes on the commercial value of the vegetable products so handled.

*Cooperation.*—Bureau of Markets and vegetable growers throughout the country.

*Location.*—Field work in various important vegetable-growing regions.

*Date begun.*—1910; cooperation with Bureau of Markets 1918.



**Results.**—Improved methods of harvesting and handling vegetable products, including lettuce, celery, tomatoes, and potatoes, to reduce losses in transit and in storage have been conducted. The influence of stowing in various quantities and different types of containers has been given attention. The stowing in cars of containers of different types and their condition on arrival have been studied, as well as the methods of relining and heating cars to insure safe delivery of perishable products during low temperatures. The influence of precooling on the transit behavior and the length of time perishable commodities will stand up on the market have been studied with lettuce and celery from Florida. Extensive commercial observation has been made of the relative behavior of sweet potatoes stowed in bulk and in various types of containers in storage houses in which the product has been cured by heat and in which the product is protected from frost.

**Sweet potatoes:** The fundamental factors in the successful storage of sweet potatoes have been determined and given wide practical application in the South. Records were secured on 77,000 bushels of sweet potatoes stored in 16 houses in the North for an average period of 106 days, and on 88,000 bushels stored in 48 houses in the South for an average period of 117 days. The average loss by decay in the North was 3.29 per cent and in the South 1.45 per cent. The minimum decay was 0.1 per cent and the maximum 4 per cent. Farmers' Bulletin 548, "Storing and Marketing Sweet Potatoes," has been published, and data are on hand for a technical bulletin on the results of the sweet-potato storage experiments.

**Celery:** The results of experiments conducted to determine the principles involved in the successful storage of celery have been published. They show the value of a small crate for storing celery. Celery keeps 30 to 40 per cent better, when stored for three months or longer, in a crate specially designed for the purpose in connection with these investigations than in the crate commonly used. In a commercial test 127 standard crates (22 by 23 by 24 inches) and 56 small crates (12 by 22 by 24 inches) were used. All the celery was packed and stored in exactly the same way and put on the market at the same time. The average price received for the large crates of celery was \$3.93, and for the smaller crates, holding only about one-half as much as the larger ones, \$2.75 per crate.

**Assignment.**—Lon A. Hawkins, H. C. Thompson, H. J. Ramsey.

**Proposed expenditures, 1918-19.**—\$500.

(See also Supplement—Emergency Activities, p. 574.)

### **Factors Affecting the Storage Life of Vegetables:**

**Object.**—To determine the critical holding temperatures of vegetables which have been produced under various environmental conditions; to determine through carefully conducted field and laboratory studies the relative importance and effects of the various factors of cultivation, fertilization, and field treatment, geographic location, physical handling, and maturity upon the storage life of vegetables.

**Procedure.**—These investigations are conducted with vegetables produced under known or controlled conditions in order that accurate information may be had regarding their development and the factors which have contributed to such development. These products are placed under holding environments the conditions of which can be controlled and measured. Different lots of the same material are placed under different environmental conditions to determine the optimum factors in environment, such as temperature, humidity, and ventilation, contributing to the longest life and best keeping conditions in storage. Material of known history, as well as commercial material, is being studied to determine the critical temperatures of products while in storage or in transit.

**Location.**—Washington, D. C.

**Date begun.**—1912.

**Results.**—Investigations with potatoes and tomatoes have been organized and material progress made with respect to several problems of fundamental importance, but conclusions can not be drawn at the present stage of the work.

**Assignment.**—Lon A. Hawkins, H. R. Kraybill, C. E. Sando.

**Proposed expenditures, 1918-19.**—\$1,500.

**Total, Vegetable-Storage Investigations, \$2,000.**



## VEGETABLE-PRODUCTION INVESTIGATIONS.

**Vegetable Production:**

*Object.*—To investigate the truck-crop and market-gardening possibilities of various sections of the United States, and to ascertain the factors limiting crop production or responsible for crop deterioration; to study the best methods of cultivating, propagating, fertilizing, harvesting, packing, and storing vegetable crops; for sweet potatoes, to determine the best cultural practices, including propagation of plants, planting, fertilization, harvesting, and storing, as well as varietal adaptability; for onions, the best growing and storage methods, as well as the possibility of producing Denia onions and growing Denia onion seed; for asparagus, the fertilizers and method of cultivation for best results; for celery, the methods of handling to overcome losses in the field and in storage; and similar work with various other standard vegetables.

*Procedure.*—Surveys of truck-growing and market-gardening districts in which the above-enumerated crops demand attention because of deterioration or losses are made to determine the factors in the cultural or handling operations which are responsible for the loss or deterioration. As soon as these factors are determined, tests are planned and inaugurated for the purpose of developing practical means of overcoming these difficulties or losses. Each crop district is carefully surveyed, the limiting factors noted so far as they can be determined, and plans inaugurated to test the effectiveness of known methods of overcoming such handicaps.

*Cooperation.*—State experiment stations of Delaware and South Carolina, the Virginia Truck Experiment Station at Norfolk, Va., and practical growers.

*Location.*—Indiana, Illinois, Maryland, New Jersey, Delaware, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Arkansas, Texas, New York, Ohio, New Mexico, California, Michigan, Florida, and Washington, D. C.

*Date begun.*—1900.

*Results.*—Data published in Farmers' Bulletins—642, "Tomato Growing in the South"; 647, "Home Garden in the South"; 934, "Home Gardening in the South"; 936, "The City and Suburban Vegetable Garden"; 937, "The Farm Garden in the North"; and 823, "Asparagus."

Sweet potatoes: A variety collection of sweet potatoes has been maintained for the purpose of securing material for storage investigations and for studying the adaptation of varieties to soil and climatic conditions. Several new varieties were added to the collection during the past year. Data in Farmers' Bulletin 324.

Onions: Denia onions produced in this country are equal to the imported product. The average yield of Denia onion bulbs is 30,000 to 40,000 pounds per acre, and as high as 60,000 pounds have been produced. Seed produced at the present time on a commercial scale is equal to the imported seed. Data have been published in Farmers' Bulletins 354 and 434, and additional data are on hand for a bulletin on Denia onions.

Celery: Data on the culture of celery are contained in Farmers' Bulletin 282.

Vegetable production on rice lands in South Carolina: Small plantings of all the standard vegetables were made during the past year, the results secured indicating that these lands, when properly drained, are adapted to vegetable production. Beets, carrots, onions, and beans did exceptionally well. Celery and lettuce gave results which indicate that they may prove valuable crops for these lands, but it has not been determined at what period in the season they should be planted to produce most satisfactory results.

*Assignment.*—H. C. Thompson, J. H. Beattie.

*Proposed expenditures, 1918-19.*—\$8,366.

**Truck-Crop Fertilizers:**

*Object.*—To determine the injurious effects, if any, of continuous heavy applications of inorganic salts to lands perpetually cropped in hoed crops; to determine the rotations which can be used in truck-crop practice which will maintain the productive capacity of the soil.



*Procedure.*—An elaborate experiment has been under way since 1908. In this work nearly all kinds of fertilizers have been used in varying amounts and combinations, with several kinds of vegetables in rotation. In addition to commercial fertilizers, manure, crimson clover, and lime are used, each alone and in combination with fertilizers. Accurate records are kept of the yields of all plats.

*Cooperation.*—Virginia Truck Experiment Station.

*Location.*—Norfolk, Va.

*Date begun.*—1908.

*Results.*—The experiments have shown the necessity of adding humus in some form in order to produce a profitable crop of vegetables and that phosphorous is the limiting fertilizer element for the soil where the experiments have been conducted. As continuous heavy applications of commercial fertilizers without humus have resulted in some cases in creating an environment in which plants do not thrive, it is evident that such applications have an injurious effect on vegetation. In addition to the results published in Bulletin 9 of the Virginia Truck Experiment Station, "Fertilizer Experiments with Kale," there are available data for other publications.

*Assignment.*—H. C. Thompson, T. C. Johnson.

*Proposed expenditures, 1918-19.*—\$100.

### **Peanuts:**

*Object.*—To improve commercial varieties of peanuts; to determine the best cultural methods, including the use of fertilizers, crop rotations, and methods of harvesting, thrashing, etc.; to extend the use of the peanut as human food and for the manufacture of peanut oil; and to demonstrate the value of the peanut as a forage crop, especially in connection with pork production in the Southern States.

*Procedure.*—Field studies are made to secure data on the methods of cultivation, fertilization, rotation, harvesting, thrashing, and the manufacture of oil and other products. In the work of improving varieties selections are made of high-yielding hills, and these are planted in experimental breeding plats and subsequent selections made.

*Cooperation.*—Virginia and South Carolina experiment stations, farmers, oil mills, cleaners, handlers; and peanut-butter manufacturers.

*Location.*—Virginia, North Carolina, South Carolina, Alabama, Mississippi, Louisiana, Texas, and Oklahoma.

*Date begun.*—1905.

*Results.*—Data contained in Farmers' Bulletins 431 and 751, Bureau of Plant Industry Circulars 88 and 98, and a special circular of the Office of the Secretary. The peanut industry is growing very rapidly and is being extended to all sections of the South. Great interest is manifested in peanut growing, especially in regions where the boll weevil is present, and in the manufacture of peanut oil. Varietal studies show that there are only six distinct varieties but some of these are represented by several different strains. Selection work shows great variation in the yield of individual plants. From each of 105 hills selected in 1915, 50 hills were planted in 1916 by the hill-to-row method.

*Assignment.*—H. C. Thompson.

*Proposed expenditures, 1918-19.*—\$3,374.

(See also Supplement—Emergency Activities, p. 555.)

### **Adaptation of Truck Crops to Organic Soils (Mucks and Peats):**

*Object.*—To investigate the adaptation of truck crops to organic soils; to study methods of treatment of different types of soils and their use in growing greenhouse crops.

*Procedure.*—Representative organic soils are selected for experimental work, both in the field and under glass. In the field work fertilizer and cultural investigations are carried on with the important vegetable crops. In the greenhouse various mixtures of organic soils, sand, and clay are used in growing the standard greenhouse vegetables and flowers. In addition to the experimental features of this work, field studies are made and data secured on the crops grown and methods of culture practiced in the various sections of the country.

*Cooperation.*—American Peat Society, Indiana Experiment Station, and practical truck growers.



*Location.*—Washington, D. C., and Indiana.

*Date begun.*—1912.

*Results.*—The results secured in connection with the fertilizer investigations with cabbage, celery, and onions grown on the type of soil used in the experiments in Indiana show that potash is there the limiting plant-food element. The value of manure was not so apparent as in 1915, though plats which received plant food in the form of manure yielded better than those receiving no plant food. Manured plats also gave better yields than those to which fertilizers containing no potash were applied. In other words, the value of the manure was due largely to the potash it contained. Nitrogen decreased the yield of both cabbage and onions. Phosphorus increased the yield over no treatment, but where used with potash salts the increase over potash alone was very slight. Greenhouse experiments show the value of some types of organic soil for forcing greenhouse crops. Chemical analyses of organic soils used in connection with these experiments proved to be of little value in determining the adaptability of those soils for crop production.

*Assignment.*—H. C. Thompson, A. P. Dachnowski.

*Proposed expenditures, 1918-19.*—\$500.

### **Production of Vegetable and Flower Seeds:**

*Object.*—To determine the most economical and successful methods of growing vegetable and flower seeds.

*Procedure.*—Field tests are conducted and the methods commonly used by seed growers in different parts of the country studied.

*Cooperation.*—Seed growers throughout the United States.

*Location.*—Washington, D. C., Arlington Farm, Va., and the farms of seed growers with whom arrangements may be made from time to time.

*Date begun.*—1907.

*Results.*—Preliminary data for publications on the growing of different kinds of vegetable and flower seeds in the United States are being accumulated. Publications issued: Bureau of Plant Industry Bulletin 184, "Production of Vegetable Seeds: Sweet Corn and Garden Peas and Beans"; and Farmers' Bulletin 884, "Saving Vegetable Seeds for the Home and Market Garden."

*Assignment.*—W. W. Tracey, sr., D. N. Shoemaker.

*Proposed expenditures, 1918-19.*—\$500.

**Total, Vegetable-Production Investigations, \$12,840, including \$2,340 statutory.**

## **VEGETABLE IMPROVEMENT THROUGH BREEDING, SELECTION, AND DOMESTICATION.**

### **Standardization of Varieties of Vegetables Through Selection:**

*Object.*—To standardize the different varieties of vegetables with a view to secure uniformity in size, season, productiveness, etc.

*Procedure.*—Seeds of the best strains of different varieties are planted, selections which conform most closely to the desired type made, seeds grown from these, and the selection continued until the desired uniformity of type is obtained.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1903.

*Results.*—Certain varieties of cauliflower and lettuce have been developed to a very high degree of uniformity, and similar progress has been made with field beans, tomatoes, and garden peas.

First selections have been made with a view to attain uniformity in the most desirable types of Witloof chicory and in certain types of Chinese Brassicas.

*Assignment.*—W. W. Tracy, sr., D. N. Shoemaker.

*Proposed expenditures, 1918-19.*—\$5,545, including \$3,450 from appropriation for the purchase and distribution of valuable seeds.

### **Improvement of Vegetables Through Hybridization and Domestication:**

*Object.*—To develop better strains and varieties of vegetables through the usual processes of crossing and hybridization.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1915.

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*Results.*—Very material gains in productiveness have been proved for the first-generation cross between selected varieties of tomatoes for greenhouse use. Poke (*Phytolacca decandra*) has been grown to determine its cultural requirements and its possibilities as a garden vegetable.

*Assignment.*—D. N. Shoemaker.

*Proposed expenditures, 1918-19.*—\$1,168.

**Total, Vegetable Improvement Through Breeding, Selection, and Domestication, \$6,713, including \$1,833 statutory.**

#### IRISH-POTATO INVESTIGATIONS.

##### Irish-Potato Investigations:

*Object.*—To determine the influence of soil and climate on the quality and productiveness of potatoes; investigate conditions necessary for the production of tubers of special merit for baking, boiling, salad, and potato-chip purposes; select and develop strains of potatoes particularly suitable to special soil and climatic conditions and for the purpose of increasing the yield per acre by eliminating unproductive hills; ascertain the best source of seed potatoes; study the influence of storage conditions on vitality, rate of germination, and crop yields; study cultural practices to improve potato culture; produce new varieties of better quality, greater disease resistance, and greater productiveness; import foreign wild and cultivated sorts to improve domestic cultivated varieties; conduct nutrition investigations to determine conditions which influence tuber development; maintain a variety collection to improve existing strains by hill selections and tuber-unit methods; observe the effect on seed potatoes of storage at different temperatures and humidity content of air on the vigor of plants produced from such seed tubers; determine the relative value of different methods of treating, handling, and cutting seed potatoes; and study the nomenclature and varietal relationships of our present commercial varieties of potatoes.

*Procedure.*—Field experiments are conducted at stations maintained at Presque Isle, Me., Norfolk, Va., Swannanoa, N. C., Greeley, Colo., Jerome, Idaho, and Arlington Farm, Va. In the irrigation investigations at Greeley, Colo., and Jerome, Idaho, the rate and date of application of water to the growing crop are being studied, for the purpose of ascertaining the effect upon the resultant health and productiveness of the plants. A test at Greeley, Colo., has in view the determination of the relative value of certified seed potatoes. A study of the relative vigor and productiveness of plants produced from mature and immature seed is under way; also experiments with potatoes to determine their relative value for culinary purposes.

*Cooperation.*—Maine Experiment Station, Virginia Truck Experiment Station, Colorado Experiment Station, and the Greeley (Colo.) Commercial Club; also nominal cooperative relationship with the Idaho and North Carolina experiment stations. The following stations are cooperating in testing promising seedling potatoes: Kansas, Nebraska, Iowa, Minnesota, Michigan, New York, Massachusetts, Rhode Island, and Vermont.

*Location.*—Arlington Farm and Norfolk, Va., Presque Isle, Me., Jerome, Idaho, Swannanoa, N. C., and Greeley, Colo.

*Date begun.*—1902.

*Results.*—About 75,000 seedlings have been grown to date, of which approximately 74,000 have been discarded as unfit for further test and approximately 1,000 are now under observation. Methods have been perfected by which uniform cooperative studies may be made as to the relative value of varieties and seedlings for culinary purposes. Data in Farmers' Bulletins 407 and 533, B. P. I. Circular 113, Department Bulletin 176, "Group Classification and Varietal Descriptions of Some American Potatoes," and Department Bulletin 195, "Potato Breeding and Selection." A Farmers' Bulletin entitled "Potato Storage and Storage Houses" also has been issued.

*Assignment.*—William Stuart, C. F. Clark, G. W. Dewey, P. M. Lombard, W. C. Edmundson, Margaret Connor.

*Proposed expenditures, 1918-19.*—\$21,840, including \$900 statutory.

(See also Supplement—Emergency Activities p. 556.)



## INVESTIGATIONS IN SYSTEMATIC OLERICULTURE.

**Vegetable History and Nomenclature:**

*Object.*—To accumulate data relating to the origin and history of varieties of vegetables, with special reference to old and little-known varieties; to assemble information relating to the origin of varieties; and to secure a simple and stable nomenclature for the cultivated vegetables.

*Procedure.*—This work is conducted through correspondence and discussion with interested parties, through the accumulation of data by reference to current and standard literature, and by verification of varieties on trial grounds at the Arlington Farm and elsewhere throughout the United States.

*Cooperation.*—Vegetable Growers' Association of America, American Seed Trade Association, horticultural societies throughout the United States, State libraries, and individual growers.

*Location.*—Washington, D. C., and various points throughout the United States.

*Date begun.*—1903.

*Results.*—Effective cooperation has been secured between the organized vegetable growers and the organized seedmen of the country with the view of reforming undesirable practices in naming and describing strains and varieties of vegetables. Unpublished data in regard to the origin and history of varieties of vegetables are being collected from various sources, including the originators of valuable strains. Publications: Bureau of Plant Industry Bulletins—6, "List of American Varieties of Peppers"; 21, "List of American Varieties of Vegetables"; 69, "American Varieties of Lettuce"; and 109, "American Varieties of Garden Beans."

Work is in progress to secure uniformity in the names used for well-recognized varieties of garden vegetables by the members of the American Seed Trade Association. The department is arranging a list of these names to be presented to the association at its next convention for consideration with a view to its adoption.

*Assignment.*—W. W. Tracy, sr., D. N. Shoemaker.

*Proposed expenditures, 1918-19.*—\$5,853, including \$500 statutory and \$3,450 from appropriation for the purchase and distribution of valuable seeds.

## VEGETABLE-UTILIZATION INVESTIGATIONS.

**Vegetable Utilization:**

*Object.*—To secure information relative to the best and most practical methods of using vegetables specially produced for the purpose or those classed as "get away" or surplus stock which can not be disposed of profitably in a fresh state.

*Procedure.*—Methods of desiccating, canning, pickling, and preserving vegetables are studied for the purpose of developing methods which can be made use of by the farmers, truck growers, or home gardeners for the purpose of conserving vegetables so as to make those of short period of growth available throughout the year and to render the product so processed in excess of the needs of the home or family suitable for market.

*Cooperation.*—Bureau of Chemistry, States Relations Service, growers, and home makers.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Results.*—Information has been accumulated on the methods of preparing, drying, curing, packing, and storing all of the more important vegetables; cost of the operation of drying with various types of evaporators; the process for converting potatoes into an acceptable flour substitute, using existing drying and grinding equipment. Data published in various press articles; a manuscript on the drying of fruits and vegetables in preparation.

*Assignment.*—J. S. Caldwell, C. A. Magoon.

*Proposed expenditures, 1918-19.*—\$3,220, including \$720 statutory.

(See also Supplement—Emergency Activities, p. 566.)

## LANDSCAPE-GARDENING AND FLORICULTURE INVESTIGATIONS.

**Landscape Gardening:**

*Object.*—To study the adaptability and uses of trees, shrubs, and other plants for ornamental planting about schools and farmsteads, on streets and roadsides, and in parks and other places; to study the regional adaptability of varieties and their relation to environment; to study the adaptability of native wild species and such other features of landscape gardening as may from time to time call for attention; also to study the most efficient and economic methods of propagating ornamental plants and to prepare planting plans.

*Procedure.*—The study of adaptability is conducted by observing the plants used for various purposes and the effects obtained. Planting plans are prepared for Government grounds when requested, also for a limited number of schools in each State, provided they are teaching agriculture, and occasionally for a farmstead where there is assurance of its being carried out and the value for purposes of demonstration seems to warrant. The regional adaptability of varieties are studied from published lists of plants thriving in specific locations by the recorded observations on plants tested at various selected stations, and in cooperation with national-forest rangers.

*Cooperation.*—Voluntary individual observers, experiment-station horticulturists, park superintendents, and Forest Service nurseries and experiment stations.

*Location.*—Washington, D. C., Arlington Farm and Norfolk, Va., Augusta and Atlanta, Ga., Ithaca, N. Y., Camden and Cleveland, Ohio, and Lafayette, Ind.

*Results.*—Data published in Farmers' Bulletins—185, "Beautifying the Home Grounds"; 248, "The Lawn"; 494, "Lawns and Lawn Soils"; and 750, "Roses for the Home"; the manuscript for a Farmers' Bulletin on "Lawn Maintenance" has been submitted, also one on "Street Trees," together with material on the planting of the farmstead, live fences, seaside plants, herbaceous perennials, and roadside trees.

*Assignment.*—F. L. Mulford.

*Proposed expenditures, 1918-19.*—\$5,767.

**Floriculture:**

*Object.*—To determine the factors controlling the propagation, growing, handling, and disposal of tender plants, cut flowers, and other plants suitable for florists' use, whether under glass or outdoors; also to determine the principles underlying the production of new varieties for this purpose, the improvement of varieties, and the domestication and introduction of wild plants of value for floricultural purposes, including hardy herbaceous and woody plants.

*Procedure.*—Trial grounds and greenhouses are maintained for testing and investigating the behavior of forced crops. Florists' and dealers' establishments and methods are studied; crosses are made of promising species and varieties; seedlings are grown and selections made. Special attention is at present given to roses, both in the open and under glass, carnations, peonies, iris, chrysanthemums, and freesias.

*Cooperation.*—Individuals, florists, American Rose Society, American Peony Society, and other floricultural societies.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1904.

*Results.*—New varieties of dahlias and chrysanthemums have been produced, and progress with similar work on carnations, roses, iris, and freesias has been made.

*Assignment.*—L. C. Corbett, F. L. Muford, E. M. Byrnes, W. Van Fleet.

*Proposed expenditures, 1918-19.*—\$4,000.

**Bulb Growing:**

*Object.*—To study the possibilities of growing bulbs of various kinds in the United States, including their propagation, cultivation, curing, storing, and testing, and to render assistance in developing a bulb-growing industry.

*Procedure.*—Representative collections of the principal kinds of flowering bulbs have been assembled at the plant-introduction bulb and field station



at Bellingham, Wash. These collections are handled in different ways for the purpose of determining cultural requirements. Bulbs propagated in different regions are grown at Bellingham for comparison with those propagated there. Different methods of propagating, curing, and storing are used in handling the Bellingham products, and the results are observed.

*Location.*—Washington, D. C., and Bellingham, Wash.

*Date begun.*—1902.

*Results.*—Bermuda Easter lilies have been grown successfully from seed. Hyacinths, narcissi, tulips, crocus, and scillas in variety have been successfully propagated and grown at the Bellingham bulb garden that compare favorably with bulbs from Holland and elsewhere. Department Bulletin 28, "Experiments in Bulb Growing at the United States Bulb Garden at Bellingham," and Bureau of Plant Industry Bulletins—39, "The Propagation of the Easter Lily from Seed," and 120, "The Propagation of Easter Lily Bulbs in the United States," have been issued.

*Assignment.*—L. C. Corbett, David Griffiths, P. H. Dorsett.

*Proposed expenditures, 1918-19.*—\$9,800.

(Ornamental Nursery: Discontinued as a separate project; included under "Landscape Gardening.")

**Total, Landscape-Gardening and Floriculture Investigations, \$19,567, including \$5,067 statutory.**

#### INVESTIGATION OF GREENHOUSE PROBLEMS.

##### Greenhouse Problems:

*Object.*—To study the methods of greenhouse, hotbed, and cold-frame construction best adapted for various purposes, together with the cost of maintaining various types of forcing structures, as well as methods of heating, ventilation, glazing, bench construction, and other details; to study soil and moisture conditions and the relation of all factors to the successful growth of ornamental and florists' plants, vegetables, and fruits under glass.

*Procedure.*—Field studies are made to secure data on the methods of construction, heating, and management of commercial greenhouses of various types. Experimental work is carried on at the Arlington Farm and at other points to determine the most efficient type of structure, most economical heating system, and the best method of sterilizing greenhouse soils. Experiments on the cultural features of the various vegetables and florists' crops commonly grown under glass are being conducted.

*Cooperation.*—Office of Farm Management and individual growers.

*Location.*—Field work in most of the States east of the Rocky Mountains.

*Date begun.*—1914.

*Results.*—Practically all the important greenhouse sections east of the Mississippi River have been visited and a study made of the construction and management of the various types of houses. Inquiries were addressed to about 3,000 commercial greenhouse establishments throughout the country. Practically all these concerns have replied, giving information as to the type, size, and use of their greenhouses, and especially as to the type of the heating apparatus in use. This information has been tabulated and shows the need for careful investigational work to determine the causes for the different results obtained in the management of present greenhouse equipment. Experiments are under way to determine the relative efficiency of different types of greenhouse structures, as well as heating equipment, in connection with the growth of standard commercial greenhouse crops.

*Assignment.*—L. C. Corbett, H. C. Thompson, J. H. Beattie.

*Proposed expenditures, 1918-19.*—\$2,500.

**Total, Horticultural Investigations, \$84,313, including \$16,873 statutory and \$6,900 from appropriation for the purchase and distribution of valuable seeds.**

## [Research.]

## ARLINGTON FARM.

**Arlington Farm:**

*Object.*—To maintain a field laboratory for the various bureaus and offices of the Department of Agriculture.

*Cooperation.*—Various bureaus and offices of the department.

*Location.*—Arlington estate, Rosslyn, Va.

*Date begun.*—1900.

*Results.*—In general, the land is being gradually improved and drainage systems extended. Additional areas have been rendered suitable and assigned to experimental work. An effort has been made to improve the farm facilities to accommodate the investigations now in progress and to render as much assistance as possible not only to this work but to any new projects that may be inaugurated.

*Assignment.*—L. C. Corbett, E. C. Butterfield, J. H. Criswell, J. L. Pelham.

*Proposed expenditures, 1918-19.*—\$37,780, including \$15,880 statutory.

## [Research.]

## EXPERIMENTAL GARDENS AND GROUNDS.

**General Care of Greenhouses and Grounds:**

*Object.*—To maintain a range of 31 greenhouses for general plant-breeding, pathological, and entomological work of the department, including seed-testing, experimental work with citrus and other subtropical fruits, vegetables, florists' crops (including roses, carnations, and chrysanthemums), etc.; to propagate plants for ornamenting the grounds of the department and those of the Weather Bureau and for congressional distribution; and to maintain the department grounds in good condition.

*Location.*—Washington, D. C.

*Date begun.*—1862.

*Assignment.*—Edward M. Byrnes.

*Proposed expenditures, 1918-19.*—\$56,310, including \$44,620 statutory.

## [Research.]

## FOREIGN SEED AND PLANT INTRODUCTION.

## GENERAL DIRECTION OF PLANT INTRODUCTIONS.

**Administration:**

*Object.*—The allotment and administration of the funds annually appropriated by Congress for foreign seed and plant introduction; supervision and direction of the scientific and clerical force incident to maintaining and extending the extensive foreign and domestic correspondence for the purpose of securing new and little-known plants of potential possibilities for American plant breeders and experimenters; directing the activities of the agricultural explorers in foreign fields and those of the scientific force in their investigations to determine the commercial possibilities and adaptability of especially promising new plant introductions to American agriculture; the maintenance of a plant-inspection laboratory and detention greenhouse, for the inspection and care of new plant introductions in accordance with the regulations of the Federal Horticultural Board; and the maintenance and direction of the Government plant-introduction field stations where the new and little-known plant immigrants are sent to be propagated, tested, and distributed.

*Procedure.*—Through agricultural explorers sent into foreign countries, extensive correspondence with American missionaries, foreign institutions, collaborators and cooperators, and the diplomatic and consular officials of the United States abroad, is being supplied the growing demand of the Federal and State experiment-station officials, cooperators, plant breeders, private experimenters, park superintendents, and directors of botanical gardens for new and rare seeds and plants for the development of new plant industries in this country. From time to time the results obtained from the experiments carried on with these new plant introductions in this country are assembled and published.



*Cooperation.*—Federal officials, State departments of agriculture, State experiment stations, agricultural colleges, schools of horticulture, botanical gardens, city park superintendents, plant breeders, co-operators, and private experimenters.

*Location.*—Washington, D. C.

*Date begun.*—Section of Seed and Plant Introduction established in 1898; project started 1907.

*Results.*—Approximately 46,000 introductions of seeds and plants have been received and distributed, a number of which have resulted in new plant industries, the money-earning value of which amounts to from a few hundred to many millions of dollars each year. Japanese rices, durum wheats, Swedish barleys, Russian oats, Sudan and Rhodes grasses, sorghums, and special dry-land, cold-region, irrigated-land alfalfas, long-staple Egyptian cotton, dasheens, tropical yams, Petsai (or Chinese cabbage), avocados, dates, mangos, seedless grapes (including the Greek "Corinth"), the sapote, the litchi, the Chinese jujube, large seedless and puckerless persimmons, and the Chinese pears and chestnuts which are more resistant to disease than those now in cultivation are some of the more important new plant introductions of positive economic importance which had their beginning in this project but now form independent projects in other offices of the bureau.

*Assignment.*—David Fairchild, P. H. Dorsett.

*Proposed expenditures, 1918-19.*—\$20,680.

### **Plant Inventory and Records:**

*Object.*—To make and maintain as complete records, photographic and otherwise, as possible of all plant introductions so as to be in a position to give an authentic, connected history of any plant introduction from the time it is secured in a foreign country until its economic value to American agriculture is established.

*Procedure.*—All importations of seed, plants, and plant products addressed to the Office of Foreign Seed and Plant Introduction when received are assigned specific numbers, and all necessary information that is available regarding the introduction, including the number, is recorded on a 4x6 card and filed. The parcels are opened and inspected by the pathological and entomological inspectors of the Federal Horticultural Board. If the material is given a clean bill of health, it is distributed; if not, it is grown in quarantine and distributed later after being passed by the inspectors. A multigraphed bulletin, "Plant Immigrants," containing descriptions of the more interesting new plant material received during the month, with a few illustrations, is sent out monthly to collaborators, co-operators, and special experimenters. The "Inventory of Seeds and Plants Imported," now in its forty-fifth number, constitutes an important literature in itself on the economic plants of the world. Each inventory contains descriptions of all the plant material received within the quarter. A record is kept of applications for new plant introductions and of domestic experimenters, plant breeders, foreign correspondents, and all plant distributions. An extensive and very valuable collection of seeds of foreign plants, as well as herbarium specimens of former introductions, is maintained for use in the determination of new introductions; also an exceptionally large and valuable collection of photographs and lantern slides of new plant introductions, showing many of the plants in their native habitat and in their new home in America.

*Cooperation.*—Department officials, investigators in the State experiment stations, public parks and botanical gardens, and private experimenters and plant breeders.

*Location.*—Washington, D. C.

*Date begun.*—1898, when Section of Seed and Plant Introduction was established; project started 1908.

*Results.*—The original field notes describing approximately 46,000 foreign plant introductions have been printed. These accounts constitute a most valuable contribution to the history of cultivated plants. Every packet of seed and every plant sent out by this office to experimenters since 1898 has been recorded on cards, so that at any time it is possible to determine what distribution was given to a new plant introduction in this country. Approximately 2,500 introductions were made last year, and 86,253 plants



and 17,127 packets of experimental seeds were placed with experimenters and a record kept of each.

*Assignment.*—David Fairchild, H. C. Skeels, G. P. Van Eseltine.

*Proposed expenditures, 1918-19.*—\$11,020.

### Placing New Plant Introductions:

*Object.*—To place the newly introduced plants in the hands of the bona fide plant experimenters of the country where they will be properly taken care of, tested, and reported upon.

*Procedure.*—Through the various plant-introduction field stations, correspondence, and by means of special agreements with plant breeders, horticulturists, and agriculturists of the State experiment stations, superintendents of city parks and arboreta, and the large number of private plant experimenters and breeders of the country, the new plant introductions are being experimented with in sections throughout the country where it is believed the best results are likely to be secured. Special inspection trips to various portions of the country are made to keep in touch with the behavior of the material sent out and the widely different climatic conditions and plant requirements of the various sections of the country.

*Location.*—Washington, D. C.

*Date begun.*—1916, as a separate project; practically in operation since the office was established in 1898.

*Results.*—As a result of the operation of this project there are growing in various sections of the country thousands of new and promising fruit and ornamental trees and shrubs, forage crops, timber trees, vegetables, windbreak plants, shelter-belt plants, avenue trees, cover crops, sand binders, drug plants, and oil-producing trees, which are being tested and reported upon. Many have already become established and have proved their adaptability to the climate of the United States. 86,253 plants and 17,127 packets of seeds were placed in the spring of 1917.

*Assignment.*—David Fairchild, Peter Bisset, David A. Bisset.

*Proposed expenditures, 1918-19.*—\$9,900.

### Protection and Propagation of New Plant Introductions:

*Object.*—To provide facilities for the adequate inspection by the officials of the Federal Horticultural Board of all newly introduced plants; to develop and apply improved methods of reproducing plants by seeds and vegetative parts in such manner that they will be free from parasitic enemies and transmissible diseases; to discover and apply improved methods for the rapid propagation, distribution, and utilization of all foreign seed and plant introductions; to work out new and improved methods of seed, seedling, and clonal sterilization against fungi and bacteria; and to conduct field tests and trials for the purpose of determining the healthiness of new or promising plant immigrants and their suitability for general distribution.

*Procedure.*—The plant-quarantine and laboratory facilities on hand in the department grounds and those at Yarrow, Md., Chico, Cal., Miami and Brooksville, Fla., and Bellingham, Wash., are utilized. In addition, special new facilities and devices will be developed from time to time for handling the work of producing healthy plants, including improved methods of soil sterilization and other special equipment and facilities for handling the various types of plant material. The greater part of the basic work is done under glass, where all the conditions are under measurable control. It is also necessary to carry the work into the field, and these field tests and studies are primarily made at the various field stations of the office.

*Cooperation.*—Federal Horticultural Board; various laboratories of the Bureau of Plant Industry.

*Location.*—Washington, D. C., and plant-introduction field stations.

*Date begun.*—1916.

*Results.*—Further improvements in the development of plans and practices for the production of disease and insect-free plant material have been made in cooperation with the superintendents in charge of the several field stations of this office. The equipment in the quarantine greenhouse and the detention houses has been materially improved. The work of receiving and handling the many introductions, so as to protect



them against dangerous diseases, has been further systematized, and closer cooperation has been effected with the inspectors of the Federal Horticultural Board. Cooperative investigations have been inaugurated to secure facts on the effects of present methods of treatment when applied to living seeds and plants. Many of the treatments now given are empirical. A considerable number are injurious to seeds and plants, particularly seeds. The object of the investigations is to develop new methods which will prove less injurious to the seeds and plants and at the same time act effectively in ridding such seeds and plants of dangerous insects and diseases. During the year about 3,500 lots of seeds, plants, etc., were received, handled, and either passed out or else grown in quarantine until safe and then released.

*Assignments.*—David Fairchild, B. T. Galloway.

*Proposed expenditures, 1918-19.*—\$11,400.

### **Plant-Introduction Surveys:**

*Object.*—To bring together in a comprehensive way for practical use all available information upon soil, climate, labor, and horsepower, use of machinery, transportation facilities, markets (present and prospective), and regional and community sentiment, with the object of applying these facts in the organization and successful maintenance of new crop industries through the introduction of foreign seeds and plants.

*Procedure.*—This project involves a study of all the machinery of the office and the field at large with a view to aid in the general advancement of the work. Plant-introduction reconnaissance inventories are being organized in order to bring together the fundamental and guiding facts which will enable the office to map and chart the regions where new foreign staple and other crops may, in the light of all the factors involved, be successfully introduced. In this work consideration must be given not only to the factors which the individual can control but also to the factors beyond his control. One of the features of the work consists of the development of ways and means for arousing and centering public interest in promising new plant products.

*Cooperation.*—Office of Farm Management, Bureau of Crop Estimates, and Weather Bureau, in addition to the various specialists in the Bureau of Plant Industry engaged in domestic crop studies.

*Location.*—Washington, D. C., Yarrow, Md., Chico, Cal., Bellingham, Wash., Brooksville and Miami, Fla., and other points where foreign seed and plant introduction experiments are under way or contemplated.

*Date begun.*—1916.

*Results.*—Owing to conditions in the country and the development of many pressing matters under the project "Protection and Propagation of New Plant Introductions," this work was more or less suspended during the past year. Considerable data, however, have been accumulating. The shifting of agricultural industries is likely to be more intensified during the period following the war, and the need for intelligent data as to the cause of these changes and the best methods of meeting them will become greater.

*Assignment.*—David Fairchild, B. T. Galloway.

*Proposed expenditures, 1918-19.*—Cost included under project "Protection and Propagation of New Plant Introductions."

**Total, General Direction of Plant Introductions, \$53,000, including \$21,100 statutory.**

### **FOREIGN EXPLORATIONS.**

#### **Major Foreign Explorations:**

*Object.*—To explore the plant industries of foreign countries with a view to secure new varieties of plants and data which will aid in their establishment in America, as well as to discover the wild relatives of cultivated plants useful for breeding with them.

*Procedure.*—This includes the work of expeditions and special explorers completed within one fiscal year. American consular officials, collaborators, and members of foreign agricultural institutions are sent on short expeditions for seeds and plants. These expeditions are sent out under authorized arrangements made during the year to meet unusual opportunities that arise.



*Cooperation.*—Various bureaus and offices of the department, foreign agricultural institutions, and United States consular officials and collaborators abroad; also foreign missionaries and private correspondents, as well as private cooperators traveling abroad.

*Location.*—Washington, D. C.

*Date begun.*—1913 as a separate project; virtually in operation, however, since 1897.

*Results.*—Short exploring trips have been made by many experts of this and other offices of the bureau to investigate definite problems of foreign agriculture and secure the seeds and plants needed to solve such problems. These trips include those made by Carleton to get the durum wheats and other cereals of Russia and Siberia; by Hansen after hardy Siberian alfalfa; by Swingle, Kearney, Scofield, Bessey, Mason, and Fairchild to secure the date palms of Egypt, Algeria, Tunis, Sudan, Arabia, and Persia; by Cook and Collins to obtain Guatemalan and West Indian avocados; by Rolfs after Mexican vanilla; by Fairchild after European barleys and hops; by Cook after Palestine wheats; by Swingle, Kearney, and Fairchild to secure the Grecian and Sicilian pistache nuts; by Knapp after Japanese short-kerneled rices; by Scofield to get the Tangier pea and other cover crops of Algeria; by Onderdonk after Mexican peaches; by Tull to obtain Japanese matting rushes; by Bolley after European varieties of flax; by Jones after potato varieties in Europe; by Piper to obtain the British Indian forage grasses; and by Shamel, Popenoe, and Dorsett after Brazilian oranges and tropical fruits. During the past year M. J. Dorsey of the Minnesota College of Agriculture explored in the vicinity of the Riding Mountains in Manitoba Province, Canada, for hardy raspberries and plums. Wilson Popenoe, who was in Guatemala after hardy types of the Guatemalan avocados, returned to this country in December, 1917, after a very successful exploration. Prof. F. C. Reimer, of the Oregon Agricultural College and Experiment Station, made a special exploration trip to China to study the wild pears of that region and secure plant material of the most blight-resistant varieties with which to experiment in this country. He and Frank N. Meyer together secured large quantities of pear seeds, which are now being tested.

*Assignment.*—David Fairchild, Wilson Popenoe.

*Proposed expenditures, 1918-19.*—\$2,500.

### Minor Foreign Explorations:

*Object.*—To explore little-known regions of the world by means of foreign correspondents and to maintain and extend such international exchange of living seeds and plants as can be done through correspondence, in order to make available to plant breeders and experimenters all over the world the materials with which new and valuable plant varieties can be produced and new plant industries created.

*Procedure.*—Through extensive correspondence with a widening circle of plant experimenters throughout the world who are domesticating wild plants and originating new varieties, carried on through the State Department and the diplomatic and consular officials abroad, through American and other missionaries and travelers in close touch with the native races among whom they are living, and through foreign botanic gardens and agricultural institutions, an extensive exchange is carried on and thousands of new plants introduced into this country every year.

*Cooperation.*—Special collaborators, the American diplomatic and consular service, American and other missionaries, foreign agricultural and botanical institutions, and private correspondence and cooperators traveling abroad.

*Location.*—Washington, D. C.

*Date begun.*—1907 as a separate project; virtually since beginning of the office in 1897.

*Results.*—Very many important introductions have been secured by this procedure. For example, new seedless and shipping varieties of table grapes have been introduced, as well as new cover crops for citrus orchards, new winter Casaba melons, the calabash pipe gourd, Australian Rhodes grass, Carib grass for Florida, the remarkably successful Sudan grass, the Feterita sorghum, collections of East Indian mangos, the Queensland nut, the chickpea or Garbanzo, the horse bean, South Chinese



peaches, Japanese flowering cherries, and new stocks for the cultivated cherry, and large collections of soy beans, rices, wheats, barleys, cow-peas, oriental persimmons, velvet beans, bananas, cork oaks, asparagus, tobacco, potatoes, and corn.

*Assignment.*—David Fairchild, Glen P. Van Eseltine.

*Proposed expenditures, 1918-19.*—\$4,200.

### South China Explorations:

*Object.*—The exploration of the Provinces of China lying southeast of Shanghai and south of the Yangtze River. which are practically unknown from the standpoint of American agriculture, for the purpose of securing collections of southern peaches, the edible and timber bamboos, the tung or wood-oil tree, and improved varieties of tallow trees; the litchi, a promising new southern fruit; the longan; an edible nut-producing oak; root crops for wet lands, varieties of rices, soy beans, remarkable southern raspberries, blackberries, and pears, rare and promising ornamental shrubs and timber trees, new varieties and species of chestnuts, and flowering bulbous plants.

*Procedure.*—This project is temporarily suspended owing to the reported death of Mr. Frank N. Meyer, the agricultural explorer, under date of June 2, 1918, near Wuhu, China. Mr. J. B. Norton will take up this project where Mr. Meyer left off and will travel through southern China searching for new varieties of our cultivated plants and their wild relatives and studying systems of agriculture employed there. He will make reports on such practices and prepare descriptions, with photographs, of varieties and species of plants which he finds there and will send in material of such of those as in his judgment will be valuable for introduction into this country.

*Cooperation.*—Through the State Department with our diplomatic and consular officials in China, with Chinese governmental officials, and American and other missionaries in the regions visited.

*Location.*—South China and, en route, Japan, the Philippines, and possibly British India.

*Date begun.*—1916.

*Results.*—Owing to the unsettled state of the country and to the fact that Mr. Meyer was instructed to wait and accompany Prof. F. C. Reimer in search of wild-pear seeds in central and eastern China, the contemplated trip to South China had to be deferred. His time during the past year, therefore, was spent in the Provinces of Shantung, Chili, Honan, Hupeh, and Kiangsu, largely in the neighborhood of Ichang and Hankow.

It is believed Mr. Meyer has made a distinct contribution to American horticulture in his researches on the wild and cultivated types of the two native Chinese pears. The Tang-li or crab-apple pear (*Pyrus calleryana*) appears to be a most promising stock for regions in this country, where the summers are hot and the winters mild, since it thrives on many types of soil and stands all kinds of neglect. The more northern species (*Pyrus ussuriensis*) is equally promising for breeding purposes for hardiness, though it is not especially adapted to dry-weather conditions. The blight resistance of these pears make them both potentially of great value. It is fortunate that this investigation was begun before all of the wild forests of these species had been cut down. They are being very rapidly destroyed. Mr. Meyer investigated the wood-oil industry of the Yangtze Valley and discovered that there are thousands of acres of hillsides in Hupeh Province suitable to its culture and that the Chinese are planting extensively there. The tree is expected to bear for only 30 years.

Continuing his investigations of the soy bean, Mr. Meyer secured some remarkable varieties of soy-bean cheeses, which compare favorably with the best milk cheeses. He investigated the yang taw and determined that it has unusual promise as a fruiting vine in the South. It produces excellent fruits, which ship well and keep well.

The Feitcheng peach, one of his introductions, has fruited in California and appears to be one of the sweetest of the cling-stone type of peaches, and promises to be excellent for canning; possibly a rival of importance with the White Heath, Phillips, Tuscan, Orange, and Lemon, which are of the Persian type. The wild Chinese peach, *Amygdalus*



*davidiana*, another of his discoveries, has proved to be in Texas a better stock than the Mariana or seedling peach upon which to bud plums or peaches.

*Assignment*.—David Fairchild, J. B. Norton.

*Proposed expenditures, 1918-19*.—\$6,000.

**Total, Foreign Explorations**, \$12,700, including \$1,200 statutory.

#### PLANT-INTRODUCTION FIELD INVESTIGATIONS.

##### Chico Plant-Introduction Field Station:

*Object*.—To grow such of the newly introduced seeds, cuttings, plants, scions, etc., as can best be propagated and tested in the climate of the locality where the station is situated, and to keep all necessary records of their behavior; to discover and eradicate any insect or fungous diseases among them, so that large numbers of small healthy plants produced from these new introductions will be available for distribution to experimenters.

*Procedure*.—Incoming seeds, plants, and plant material are sent to this station and recorded. This material is planted out, tested preliminarily, and propagated. It is then distributed into the sections of the country deemed suitable to its growth for further testing.

*Location*.—Chico, Butte County, Cal.

*Date begun*.—1904.

*Results*.—During the past year over 59,095 new plants were propagated and 50,791 distributed, exclusive of figs, pistaches, grapes, etc., grown for other offices of this bureau. These included such important introductions as the Chinese pears of marked resistance to pear blight; hybrid chestnuts, and a Chinese variety more or less resistant to the chestnut blight; Russian apples recommended for regions having long, hot summers; the large Fei peach from China, a very promising canning variety; the Chinese jujube, a new tree fruit adapted to the warmer semiarid West and Southwest; early-ripening olives, the carob fodder tree, a dwarf lemon, large-fruited haws, the Chinese dry-land elm (which is giving excellent satisfaction for shelter-belt planting in the northern Great Plains region), the Chinese "Yang-taw" (a valuable fruiting vine), pears from Spain, the Queensland nut from Australia, and the dry-land bur clovers from Algeria; with scores of others of more or less promising economic importance.

The special appropriation of \$35,000 secured last year for the purchase, preparation, and irrigation of not to exceed 150 acres of land at Chico, Cal., has been expended for the purchase of the Livingstone property, consisting of 8 acres at the southwest corner of the station, at a cost of \$3,500, and the Stone property, adjacent to the station on the north, containing 122 acres, more or less, with a ditch and water right to something like 300 miner's inches of water, at a cost of \$30,000. The balance of \$1,500 has been expended in the preparation of the properties for use as an enlargement of the present garden.

*Assignment*.—David Fairchild, P. H. Dorsett, B. T. Galloway, Peter Bisset, R. L. Beagles.

*Proposed expenditures, 1918-19*.—\$14,200.

##### Miami Plant-Introduction Field Station:

*Object*.—Same as Chico station.

*Procedure*.—Same as Chico station.

*Location*.—Miami, Dade County, Fla.

*Date begun*.—1907.

*Results*.—During the past year over 40,936 plants were propagated, but only 7,478 were distributed, owing to war and quarantine conditions. These included the important varieties of the East Indian mango, now grown throughout subtropical Florida, the best varieties of anonas, the remarkable fragrant-flowered, edible-fruited hedge plant carissa; the Mexican leguminous shade tree *Pithecolobium*; small-fruited papayas, the West Indian akee, the Rhodes grass, the yam and bonavist beans, the cajaput tree for swampy lands; and the specially selected types of hard-shelled, hardy Guatemalan avocados secured by Mr. Wilson Popenoe in 1917-18; and many others have come into general use through



the activities centered in this station and have aided in building up a new type of agriculture suited to southern Florida and southern California. The development of the new 25-acre permanent garden is well under way, avocado, mango, annona, and other tropical fruit areas having already been planted on it.

*Assignment.*—David Fairchild, P. H. Dorsett, B. T. Galloway, Peter Bisset, Edward Simmonds.

*Proposed expenditures, 1918-19.*—\$6,440.

#### **Brooksville Plant-Introduction Field Station:**

*Object.*—Same as Chico station.

*Procedure.*—Same as Chico station.

*Location.*—Brooksville, Hernando County, Fla.

*Date begun.*—1909.

*Results.*—During the past year upwards of 24,395 plants were propagated and 1,624 distributed. Because of the war and the restrictions of the Federal Horticultural Board, the distribution of the balance of the plants propagated was prevented. The dasheen crop for the season amounted to 1,350 bushels, while that of the chayotes was upwards of 8,200 fruits. A test nursery and test orchard have been established, and all but about 5 acres of the 35 in the station has been cleared of forest, stumps, and roots and is now under cultivation. Interesting and valuable data are being secured from the experimental plat and crop-rotation work for nematode control. Many valuable data have been secured here regarding the oriental bamboo, its culture, diseases, and soil requirements through the maintenance of an experimental bamboo grove of several acres.

*Assignment.*—David Fairchild, P. H. Dorsett, B. T. Galloway, Peter Bisset, J. E. Morrow.

*Proposed expenditures, 1918-19.*—\$8,320.

#### **Rockville Plant-Introduction Field Station:**

*Object.*—Same as Chico station.

*Procedure.*—Same as Chico station.

*Location.*—Near Rockville, Montgomery County, Md.

*Date begun.*—1910.

*Results.*—During the past year over 55,789 new plants were propagated and 25,360 distributed. These included tung or wood-oil trees, seedling and budded Japanese flowering cherries, *Prunus tomentosa* for the Northern States, Japanese bamboos, seedling hybrid grapes for the Office of Pomology, windbreak plants, dry-land Chinese poplars for cold Northern States, Chinese chestnuts more or less resistant to the chestnut blight, a Chinese elm especially adapted to the drier States, and other shade trees and dooryard shrubs for dry and arid regions. Upwards of 8,000 Guatemalan seedling avocados have been grown and a good percentage of them budded to the 23 specially selected hard-shelled fruiting type secured in Guatemala by Mr. Wilson Popenoe.

A soil sterilizer has been perfected, and all plants grown in the greenhouse are planted in sterile soil. By this means root nematode has practically been eliminated from the plants grown in pots in the houses. Three hundred bushels of soy beans were grown and harvested on the place and turned over to the Office of Seed Distribution for congressional distribution. Something like 200 acres of additional land near by has been rented, which, with 100 acres on the "Yarrow" station, will be planted to new and little-known soy beans and cowpeas. This work is in cooperation with the Office of Seed Distribution, and the seed harvested will be distributed to farmers next season through the latter office.

The stringent methods of inspection and fumigation observed in connection with the greenhouses of this station make it virtually a quarantine station for all material about which there might be a slight suspicion.

*Assignment.*—David Fairchild, P. H. Dorsett, B. T. Galloway, Peter Bisset, J. M. Rankin.

*Proposed expenditures, 1918-19.*—\$16,240.

**Bellingham Plant-Introduction Field and Bulb Station:**

*Object.*—Same as Chico station.

*Procedure.*—Same general procedure as at Chico station. The station will be developed and financed by this office. It is expected that the new nursery plants from Europe and the Great Central region of China can be more satisfactorily propagated at this station than at any of the other existing stations. The bulb work under the direction of Dr. David Griffiths and financed by the Office of Horticultural and Pomological Investigations will, in the summer and fall of 1918, be transferred from the leased land where it is now being conducted to this station and be handled cooperatively as other cooperative work has been handled at the Chico station.

*Cooperation.*—Office of Horticultural and Pomological Investigations.

*Location.*—Bellingham, Whatcom County, Wash.

*Date begun.*—1916.

*Results.*—Something like 40 of the 57 acres of the new plant-introduction field station and bulb garden have been cleared and put under the plow, and of these 40 acres something like 10 acres are being made ready for the planting of bulbs this fall. A cottage for the superintendent, a temporary cottage for one of the workmen, and a barn have been erected, and the bulb house is now in course of construction and will be ready for the storage of bulbs at harvest time. A considerable quantity of the Chinese white-barked pine (*Pinus bungeana*) and seed of other plants were planted at this station last fall.

*Assignment.*—David Fairchild, P. H. Dorsett, B. T. Galloway, Peter Bisset, H. E. Juenemann.

*Proposed expenditures, 1918-19.*—\$12,160.

**Avocado Introduction:**

*Object.*—To introduce, propagate, and distribute rare and valuable varieties of avocados; to determine the best methods of cultivation and propagation; to secure more hardy strains and types free from dangerous and destructive diseases; and to aid generally in the successful establishment of an avocado industry in this country.

*Procedure.*—New introductions of the avocado are being constantly made. Improved methods of propagation are being developed, diseases and other enemies studied, complete sets of disease-free and insect-free types grown, and sources of useful stocks determined.

*Cooperation.*—Cooperators and collaborators in Florida and California; Citrus Station, Riverside, Cal.

*Location.*—Washington, D. C., Yarrow, Md., Miami and Brooksville, Fla., and Chico, Cal.

*Date begun.*—1909.

*Results.*—Numerous varieties of avocados have been introduced, a number of which are now in successful commercial cultivation. Test orchards and nurseries have been established, chiefly at or near Miami, Fla. Numbers of the most promising varieties have been distributed. The explorations of Mr. Wilson Popenoe in Guatemala resulted in securing 23 new and distinct promising types. These have all been handled through the plant-quarantine and detention houses of this office and insect-free and disease-free stock secured. About 8,000 seedlings have been grown for stocks, and about one-fourth of these have been budded with the Guatemalan types. Fruiting-out tests in Florida and California have been arranged for, after which the most promising types will be distributed. Several new diseases have been studied and new and improved methods of propagation developed. Complete or nearly complete sets of Mr. Popenoe's valuable types are now established at Washington, D. C., Yarrow, Md., Miami, Fla., and Chico, Cal. These sets are wholly free from dangerous diseases and insects and are to prove the sources of stock for wider distribution as soon as the fruiting-out field tests have been completed.

*Assignment.*—David Fairchild, Wilson Popenoe, B. T. Galloway, Peter Bisset, Edward Simmonds.

*Proposed expenditures, 1918-19.*—Included in amounts allotted to the field stations and "Major Foreign Explorations."



**Udo Introduction:**

*Object.*—To secure the best varieties of this Japanese vegetable and demonstrate its possibilities as a home-garden vegetable and for commercial growing.

*Procedure.*—The best strains known have been introduced from Japan, propagated, and distributed.

*Location.*—Plant-introduction field stations at Rockville, Md., and Chico, Cal.

*Results.*—This remarkable new salad plant is being tested by private experimenters over an extended area of the country. Upwards of 12,250 plants were propagated and distributed during the past year. Negotiations are in progress by which it is hoped that a commercial planting of one-fourth to one-half acre of this little-known Japanese vegetable can be grown by one of the foremost vegetable growers in New Jersey to demonstrate its economic importance.

*Assignment.*—David Fairchild, Peter Bisset.

*Proposed expenditures, 1918-19.*—Nominal; included in allotment for Rockville station.

**Mango Introduction:**

*Object.*—To encourage the establishment of commercial mango growing in this country.

*Procedure.*—New varieties of this fruit are introduced, propagated, and distributed. These varieties are also fruited and compared with varieties already grown in this country.

*Cooperation.*—Private experimenters and cooperators in Florida and California.

*Location.*—Plant-introduction field stations at Miami, Fla., Chico, Cal., and Rockville, Md.; Homestead and Miami, Fla., and other points in Florida where private experimenters are conducting tests.

*Date begun.*—1900.

*Results.*—Over 400 different introductions have been propagated and distributed, resulting in bearing trees and groves scattered throughout Florida. These have been subjected to various more or less severe freezes, and certain varieties have shown a greater degree of hardiness than others. Field investigations have been made in Florida, Cuba, Isle of Pines, and Porto Rico to discover the causes of the failure of certain varieties to bear. The first experiment failed of any special results, probably because performed too early in the spring. However, branches of mango trees that were rung last August have set a heavy crop of fruit, but no fruit to speak of has set on the ungirdled limbs. This work will be repeated and enlarged this season.

*Assignment.*—David Fairchild, Wilson Popenoe, Edward Simmonds.

*Proposed expenditures, 1918-19.*—Nominal; included in allotments for field stations.

**Dasheen Introduction:**

*Object.*—To introduce a tuberous root crop into the warmer, moist sections of the United States, where climatic conditions make the growing of Irish potatoes uncertain and especially where the potato can not be grown as a fall crop; to utilize different tuberous crops, other than the dasheen, in definite systems of rotation which will make it practicable to grow the dasheen crop as a part of a general system that will free the land of nematodes and will permanently stabilize the industry; in short, to make the dasheen serve the same purpose in parts of the South that the Irish potato serves in parts of the North, where the latter constitutes one of the cash crops, in definitized rotation schemes.

*Procedure.*—New varieties are introduced from foreign countries and tested in comparison with varieties already grown in this country. These varieties are improved by selection. Large quantities of dasheen tubers are propagated and distributed to private cooperators for planting and for experimental table use. Experiments are conducted to determine the best methods of cooking and serving dasheen tubers, flour, leaves, and blanched shoots. Limited quantities of tubers are distributed to the domestic science departments of State universities, to cooking schools,

and to leading clubs, hotels, and restaurants, when their cooperation can be secured, in an effort to establish a market for the dasheen. Rotation tests will be inaugurated in cooperation with farmers that will show the practicability of utilizing the dasheen in rotation with corn and other crops of economic promise known to be resistant to nematodes.

*Location.*—Washington, D. C., the plant-introduction field station at Brooksville, Fla., and various points in the Southern and Gulf States.

*Date begun.*—1905.

*Results.*—A large stock of seed dasheens, free from root-knot, was reserved from the 1917 crop for distribution to experimenters. Tubers were sent, in the spring of 1918, to about 900 planters, mostly in the Southeastern States and westward to eastern Texas. About 18,000 pounds of dasheens were distributed in the season of 1917-18, mostly in eastern and northern cities and through home-demonstration agents in the South, to demonstrate to consumers the merits of the vegetable as a food and to show to farmers and gardeners its desirability and value as a crop. As a result of these and other activities, the demand for dasheens has increased considerably, in both the North and the South. They have been put on the market in a number of the large cities, from New York to Kansas City. One eastern market took more than 200 barrels. At least 50 farmers grew dasheens in commercial quantities in 1916.

*Assignment.*—R. A. Young, J. E. Morrow, L. G. Hoover.

*Proposed expenditures, 1918-19.*—\$3,000.

### **Bamboo Introduction:**

*Object.*—To introduce and establish the edible and timber bamboos in sections of the United States where these plants will succeed and to encourage their planting in commercial quantities.

*Procedure.*—The bamboo plants are introduced and propagated and the rhizomes distributed. Cooperation is arranged with American manufacturers using bamboo in connection with the utilization of domestic-grown cane. The utilization of bamboo shoots as a vegetable is being exploited.

*Cooperation.*—Private growers.

*Location.*—Plant-introduction field stations at Brooksville, Fla., Chico, Cal., and Rockville, Md., and cooperative planting at Avery Island, La.

*Date begun.*—1907.

*Results.*—Over 100 different introductions have been tested. The plantings at Brooksville were heavily manured last summer and are making excellent growth. Plants from the grove of a large timber variety at Savannah, Ga., have been secured for propagation and arrangements made for securing the young shoots this spring for cooking tests. The experimental planting of both the edible and timber bamboo at Avery Island, La., is doing well. The general interest in regard to the economic possibilities of this wonderfully useful class of plants to America is increasing and, as basket making and other bamboo trades offer possibilities of an occupation for our maimed soldiers who will have to be taken care of, immediate steps possibly should be taken to establish extensive plantings of bamboo throughout the South. The occurrence of serious bamboo diseases in several of the American bamboo plantations makes it appear necessary to take unusual steps for the eradication of these diseases and to start new plantations with plants known to be free from diseases.

*Assignment.*—David Fairchild, Peter Bisset, J. E. Morrow.

*Proposed expenditures, 1918-19.*—Included in allotments for field stations.

### **Litchi Introduction:**

*Object.*—To introduce and establish the Chinese litchi as a new fruit industry in this country; to secure the most promising varieties, and to develop improved methods of propagation; to test stocks; to introduce seed and seedlings for stocks; to make a critical study of the botanical relationships of the litchi in order to secure data that will be helpful in breeding and related work; to make a critical study of climatic and soil requirements in order to act intelligently in the development of the industry.



*Procedure.*—Improved varieties are being introduced and assembled in Washington where they may be critically studied and more rapidly propagated. Numerous seedlings of the various species and types are being grown for promising stocks. Experiments in more rapid propagation, through the use of cuttings, have given promising results. As large a collection of promising types as is practicable will be assembled as a prerequisite to field tests on a scale that will be conclusive.

*Location.*—Washington, D. C., and Miami, Fla.

*Date begun.*—1907.

*Results.*—Only the beginnings of the new collection can be reported on. Several hundred of the various species of *Nephelium* and related genera are on hand. New seed is being received from time to time. A collection of authentic varieties is slowly growing in numbers under improved methods of propagation.

*Assignment.*—David Fairchild, B. T. Galloway, Edward Simmonds, Edward Goucher.

*Proposed expenditures, 1918-19.*—Nominal; included in allotments for field stations.

### Chayote Introduction:

*Object.*—To place better strains and varieties in the hands of cooperators and experimenters throughout the Southern States and to exploit this vegetable on the northern market.

*Procedure.*—This project involves the introduction, propagation, and distribution of better and improved strains of chayote; also the culinary testing of this vegetable.

*Location.*—Plant-introduction field station at Brooksville, Fla., and other points in the South Atlantic and Gulf States.

*Date begun.*—1910.

*Results.*—A large number of seed chayotes, including remarkable new varieties from Guatemala, have been introduced and tested at the Brooksville station. The best varieties are being distributed, with assistance from county home-demonstration agents, to experimenters and commercial growers as the value of these varieties is determined. Several thousand chayotes have been distributed for culinary tests, and the reports from pickle experts and others indicate that this vegetable will prove a valuable one for both home use and the market. The chayote is found to store well at cool temperatures (about 50° F.). A spring as well as a fall crop has been raised by special fertilization of plants one year or more old. Two acres of chayotes are being grown at the Brooksville station, and an arrangement has been made with a commercial grower at Jacksonville, Fla., whereby the department can obtain more fruits for propaganda work or seed, if needed.

*Assignment.*—R. A. Young, J. E. Morrow, L. G. Hoover.

*Proposed expenditures, 1918-19.*—\$1,000.

### Almond Introduction:

*Object.*—To secure and introduce better varieties of almonds for breeding and commercial tests.

*Procedure.*—The work consists of the introduction, propagation, and distribution of improved almonds.

*Location.*—Plant-introduction field station at Chico, Cal.

*Date begun.*—1907.

*Results.*—The hard-shelled Spanish almonds have been introduced and tested, and experiments are under way with Chinese bush almonds, new possibilities for the Southwest. Over 100 different introductions have already been made, several of which show promise of being improvements over old varieties.

*Assignment.*—David Fairchild, R. L. Beagles.

*Proposed expenditures, 1918-19.*—Nominal; included in allotment for Chico station.

**Tung Tree Introduction:**

*Object.*—To introduce, establish, and grow tung oil (or wood-oil) trees commercially in the United States.

*Procedure.*—Seeds grown in this country are propagated and the seedlings distributed. An attempt to increase the acre yield of oil by pruning, selection, and budding is being made.

*Cooperation.*—Experimental plantings at the Georgia and Alabama experiment stations.

*Location.*—Plant-introduction field stations at Rockville, Md., and Chico, Cal., and various points in Florida, California, Alabama, and Georgia.

*Date begun.*—1905.

*Results.*—Although the high price of tung oil in this country and the fact that new uses for the oil are being discovered give reason to hope that a paying industry in tung-tree culture may yet be established in the South Atlantic and Gulf States, it appears that the strains of the tree now under cultivation are too susceptible to the sudden heavy freezes occurring every few years to make this promising. Early in 1917 many trees up to 10 years old were either killed or seriously injured by a severe freeze following a very warm period. Active work in this project has been suspended for the present, but further data on the whole subject will be obtained as opportunity offers.

*Assignment.*—David Fairchild, R. A. Young.

*Proposed expenditures, 1918-19.*—Included in allotments for field stations.

**Introduction of Chinese Jujube:**

*Object.*—To introduce the Chinese jujube into the United States; to conduct tests and experiments for the purpose of locating regions where the industry is most likely to succeed; to study the geographical distribution, the botanical relationships, and the reaction to climate and soils of foreign cultivated and related species, with the view to applying here the knowledge thus gained; to improve methods of propagation; and to conduct laboratory and field studies in the utilization and marketing of the fruit.

*Procedure.*—Collections of *Zizyphus* and related species and varieties from foreign countries are being assembled for study, breeding purposes, and propagation at Chico, Cal. Test orchards for fruiting out the various forms have been established. Breeding experiments will be made to improve existing forms. Cooperative commercial tests will be inaugurated. Improved methods of propagation developed, and laboratory and field work carried on for the purpose of determining the best methods of utilizing the fruit.

*Location.*—Chico, Cal., and Washington, D. C.

*Date begun.*—1910.

*Results.*—About 40 varieties of the jujube have been introduced into the United States. Nearly all of them are now assembled at the plant introduction field station at Chico, Cal. Between 7,000 and 8,000 seedlings have been bench-grafted to the best varieties. Considerable data have been accumulated on the relative value of some of the forms for stocks. Something over 1,200 grafted plants have been distributed for the purpose of developing commercial plantations of this promising new fruit. The greater portion of these were sent to eight widely scattered regions in California. One commercial test is being made in Texas in cooperation with the Texas Agricultural Experiment Station. Some suggestive data have been secured as to the ability of the jujube to withstand alkali soils. It may also be noted that certain of the jujubes have been raised from cuttings and that some of the varieties bear fruit on the old wood, contrary to the usual habit of bearing fruit on deciduous branchlets. Some preliminary experiments in the processing, conservation, and utilization of the fruits of the jujube have been made at Chico, Cal., and in the laboratory at Washington, D. C.

*Assignment.*—David Fairchild, B. T. Galloway, Peter Bisset, R. L. Beagles.

*Proposed expenditures, 1918-19.*—\$540.

**Introduction of Carob Trees:**

*Object.*—To import, propagate, and distribute the most promising productive varieties of this important forage tree, and to determine the best pollinating varieties and the best methods of establishing orchards in this country.



*Procedure.*—The best known varieties and highest yielding strains are imported from Spain and other countries of southern Europe. These are propagated and seedlings and budded trees distributed.

*Location.*—Plant-introduction field station at Chico, Cal.

*Date begun.*—1910.

*Results.*—The best Spanish, Portuguese, Algerian, and Grecian varieties have been introduced, and seedling trees in southern California have been grafted with these better-yielding sorts, which produce sweeter and more nutritious pods, and much interest in this drought-resistant, long-lived forage tree has been aroused.

*Assignment.*—David Fairchild, Peter Bisset, R. L. Beagles.

*Proposed expenditures, 1918-19.*—Nominal; included in Chico station allotment.

### **Persimmon Introduction:**

*Object.*—To introduce better-yielding, longer-lived, larger-fruited, and less astringent varieties of the oriental persimmon, *Diospyros kaki*, and to secure the stocks upon which to grow them.

*Procedure.*—Seeds and cuttings of these forms are introduced from China, Japan, and the oriental tropics. The plants are then propagated and distributed. An investigation of the oriental persimmon industry is made by explorers and correspondents.

*Cooperation.*—State experiment stations and private experimenters.

*Location.*—North Carolina, Florida, Georgia, and California.

*Date begun.*—1910.

*Results.*—Field investigations were made of the persimmon regions in China by Mr. Frank N. Meyer, agricultural explorer, in conjunction with his explorations in northwestern China, especially of the white-barked persimmon in Chekiang Province, a stock for wet lands. Photographs were secured and arrangements made to procure seeds. Two new varieties were sent in from the Kansu Province. A large collection of Japanese varieties was also imported. In all, over 400 introductions have been made and the plants propagated and distributed, including the large seedless Tamopan variety from China and the equally important Fukuya variety from Japan, both remarkable for their non-astringent character.

*Assignment.*—David Fairchild, Peter Bisset.

*Proposed expenditures, 1918-19.*—Included in field-station allotments.

### **Introduction of Street and Park Plants:**

*Object.*—To introduce, propagate, and distribute new and rare varieties of shrubs, trees, and other plants for testing to determine their economic importance for civic improvement purposes and for use in dooryard gardens.

*Procedure.*—This includes the introduction, propagation, and distribution of new and rare shrubs, trees, and other plant material deemed valuable as additions to those already grown in this country.

*Cooperation.*—Private experimenters, nursery firms, park superintendents, civic-improvement societies, and other domestic institutions.

*Location.*—Washington, D. C., and plant-introduction field stations.

*Date begun.*—1911.

*Results.*—Hundreds of varieties of trees and shrubs have been introduced, propagated, and placed in experimenter's hands for trial. Those sent out for testing last year include new and rare forms of ornamental vines, such as actinidia, clematis, ipomœa, and ampelopsis; shrubs and small trees adapted to dooryard and park uses, such as barberries, oleasters, honeysuckles, hardy roses; rhododendrons, junipers, euonymus, and cotoneasters; carnauba, oil, fan, and uchul palms; and street and windbreak trees, such as oaks, pines, poplars, willows, elms, tamarisks, maples, and chestnuts, many of which are adapted to cultivation in the semiarid regions of the Southwest and the northern Great Plains region.

*Assignment.*—David Fairchild, Peter Bisset.

*Proposed expenditures, 1918-19.*—Included in allotments for field stations.

### **Introduction of Pistache Nut:**

*Object.*—To introduce from foreign countries improved varieties of the pistache and to propagate the same for distribution.

*Procedure.*—Promising varieties are introduced, propagated, and distributed.

*Cooperation.*—Office of Crop Physiology and Breeding Investigations.

*Location.*—Washington, D. C., and plant-introduction field stations.

*Date begun.*—1910.

*Results.*—Superior budded varieties and stocks have been distributed in limited quantities. An extremely ornamental form, *Pistacia chinensis*, has been given wide distribution. Several of the best Italian and Syrian varieties fruited for the first time at Chico and demonstrate the possibility of pistache culture in this country. Stocks are on hand for the production of large quantities of budded plants next year.

*Assignment.*—David Fairchild.

*Proposed expenditures, 1918-19.*—Included in allotments for field stations.

### **Papaya Introduction:**

*Object.*—To discover and disseminate superior varieties of the papaya with fruit having a better flavor and better shape for shipping purposes than the ordinary seedling papaya and which will come reasonably true to seed; to investigate the best method of propagating the papaya in order to prevent the deterioration of varieties; to disseminate other species of *Carica* of possible use for breeding with *Carica papaya*; and by the extensive distribution of the plants to discover regions in the Southern States where the papaya may be grown and fruited as an annual.

*Procedure.*—Includes the introduction, propagation, testing, and distribution of seeds and seedling plants.

*Location.*—Washington, D. C., and the plant-introduction field station at Miami, Fla.

*Date begun.*—1912.

*Results.*—Nearly 200 introductions have been made; thousands of plants (seedlings) and many packets of seed, also grafted plants in limited numbers, distributed to special cooperators; correspondence conducted with manufacturing chemists regarding the establishment of commercial plantings of *Carica papaya* for the production of papain. There is now being started in southern Florida a 40-acre planting of *Carica papaya* for the production of papain. This is the first successful commercial plantation in America, and from it were sold large quantities of fruit to the local hotels in Florida. New methods of securing a plantation of female plants have been worked out there.

*Assignment.*—David Fairchild, Edward Simmonds.

*Proposed expenditures, 1918-19.*—Included in allotment for Miami station.

### **Introduction of Annonaceous Fruits:**

*Object.*—To establish as industries the culture of the various subtropical fruit trees belonging to the class Annonaceæ and known as sugar apple, cherimolias, sour sops, rollinias, etc.

*Procedure.*—All the promising species of plants of this class occurring in foreign countries are obtained and tested and established in special gardens. The best sorts are selected and propagated to provide material for plant breeders and other experimenters desirous of planting orchards of these delicious fruits.

*Cooperation.*—State experiment stations.

*Location.*—Washington, D. C., and the plant-introduction field station at Miami, Fla.

*Date begun.*—1916.

*Results.*—Many introductions of annonaceous plants have been made, and these have been established in orchard form at the Miami field station, where they will be available for breeding and selection purposes. The largest collection in the world of varieties and species of fruit trees of this class has already been assembled there, and at least one hybrid, the result of a cross between *Annona squamosa* and *A. cherimolia*, is exceptionally promising both as regards quality of fruit and hardiness of tree. A new and hardy species from Paraguay has been introduced which withstood a temperature of 26° F.

*Assignment.*—David Fairchild, Edward Simmonds, Wilson Popenoe.

*Proposed expenditures, 1918-19.*—Included in allotment for Miami station.



**Chinese Wild Peach Stock Introduction:**

*Object*.—To test the Chinese wild peach (*Amygdalus davidiana*) as a stock on which to bud or graft the various stone fruits, such as peaches, apricots, almonds, nectarines, and plums, in order to determine whether it is as long lived, alkali and drought resistant, and otherwise valuable a stock for these fruit trees in America as it has proved to be by centuries of trial in China.

*Procedure*.—Seeds of this species have been introduced from China and are budded with standard American varieties of stone fruits and tested in various parts of this country by State experiment stations and private experimenters.

*Location*.—Washington, D. C., and plant-introduction field stations at Chico, Cal., and Rockville, Md.

*Date begun*.—1916, as a separate project; formerly carried under "Minor Plant Introductions."

*Results*.—Mr. Frank N. Meyer, agricultural explorer, on visiting nursery gardens near Tientsin, China, found that Chinese gardeners had grafted flowering plums upon a stock which resembled the almond. Upon inquiry he found that the Chinese name for this stock literally meant "mountain peach tree." Further investigations proved this to be *Amygdalus davidiana*. Approximately 3,000 pounds of seeds, together with specimens and photographs, were sent in by Mr. Meyer. Plants were grown from these seeds and distributed all over this country. These *davidiana* peach stocks have been tested in various places in the United States, including Chico, Cal., Ames, Iowa, and San Antonio, Tex., and have proved hardy on the northern edge of the peach belt of Iowa and drought and alkali resistant in central Texas and in Arizona and California. Experiments which have been conducted since 1905, when this remarkable wild peach was first introduced, have proved this plant to be so promising as a stock for practically all stone fruits (cherries excepted) for semiarid regions that it is considered important enough to handle it as a specific project.

*Assignment*.—David Fairchild, Peter Bisset.

*Proposed expenditures, 1918-19*.—Included in allotments for field stations.

**Chestnut Introduction and Distribution:**

*Object*.—To continue the work of chestnut introductions and the introduction of allied plants for the purpose of aiding in the rehabilitation of the chestnut industry now practically destroyed as a result of blight; to aid breeders and others by supplying types from the Orient and elsewhere that may be useful in developing new strains valuable for nuts and for wood and as ornamentals; and to aid in the distribution and testing of types resulting from breeding the forms secured through foreign explorations.

*Procedure*.—Explorations for promising chestnuts and related species will be continued. The various species, types, and forms already brought in will be reassembled and more critically studied and propagated for testing out on a commercial scale. Special material of promise for breeding will be grown and furnished to breeders in the department and elsewhere who are interested in the breeding work.

*Cooperation*.—Office of Horticultural and Pomological Investigators, State experiment-station workers, and private growers.

*Date begun*.—1918.

*Results*.—A number of foreign introductions have been made, chiefly through Mr. Frank N. Meyer. Several thousand seedlings have been assembled, these being chiefly of promising hybrids developed by Dr. Walter Van Fleet. Some promising types as stocks have been secured. Something over a thousand grafts have been made of Mr. Meyer's *Castanea molissima* and some of the best of Dr. Van Fleet's hybrids.

*Assignment*.—David Fairchild, B. T. Galloway.

*Proposed expenditures, 1918-19*.—Included in allotments for field stations.

**Pyrus Introductions for Stocks, Breeding, and Other Purposes:**

*Object*.—To assemble and critically study the various species and varieties of *Pyrus* introduced and distributed by the Office of Foreign Seed and Plant Introduction since its inception; to assemble and critically study any other *Pyrus* introduced, and to introduce new and promising foreign species and varieties for the purpose of supplying experiment-station workers and others with material for the improvement of pear cul-



ture through the use of better and more uniform stocks—stocks resistant to fire blight, leaf blight, and other diseases, and stocks that may be propagated rapidly by cuttings or in other ways than seed—so as to insure uniformity of type; to encourage experiment-station workers and others to test the relative adaptability of certain *Pyrus* species and varieties of stocks to soil types and climate; to study the relative congeniality of our more valuable cultivated pears to new and promising stocks; to secure material for distribution, and to encourage by such distribution the breeding of blight-resistant and other disease-resistant pears for more extended commercial and home use, especially in the South; to develop methods, locate regions, and assist the nursery trade in the introduction and production of American-grown pear stocks free from dangerous foreign insects and diseases and better adapted to American needs and conditions.

*Procedure.*—Nearly 400 pear introductions have been made by the Office of Foreign Seed and Plant Introduction. These have been widely scattered but have not been critically studied. A complete inventory of all former introductions will be made, and the more promising types will be critically studied and tested. Propagating nurseries and test nurseries will be established at Chico, Cal., Brooksville, Fla., and Yarrow, Md. Laboratory and field studies in new methods of propagation will be inaugurated. Special attention will be given to the securing of material for distribution to experiment-station workers and plant breeders for the purpose of aiding in the rehabilitation of American pear growing and the stabilization of the industry. The development of an American pear-stock industry will be made a special feature.

*Location.*—Washington, D. C., Chico, Cal., Yarrow, Md., Brooksville, Fla., and various selected regions throughout the country.

*Date begun.*—1918.

*Assignment.*—David Fairchild, B. T. Galloway, Peter Bisset.

*Proposed expenditures, 1918-19.*—Included in allotments for field stations.

### **Nursery-Stock Introduction, Protection, and Propagation:**

*Object.*—To secure from all available sources definite information and statistical data regarding the nature, kinds, and quantities of nursery stock introduced into this country, the sources of such stock, its ultimate destination, and the enemies to which it is subject and which may be sources of potential danger to American crops; to study the best methods of protecting introduced nursery stock from diseases and other enemies, and to aid in the introduction of disease and insect free stock for propagation purposes; to investigate methods of growing and propagating nursery stock in this country, and to determine the regions best adapted to this work.

*Procedure.*—Owing to many serious insect pests and plant diseases brought into the country on nursery stock and the constant danger arising therefrom, it may be necessary gradually to exclude much of this stock. These matters of exclusion fall within the province of the Federal Horticultural Board. To aid the board in such fashion that intelligent action may be taken, data will be secured showing the sources from which so-called nursery stock now comes, the kinds and quantities of material introduced, and the probable or potential enemies it will be necessary to provide against. Steps will be taken to ascertain and locate regions in this country best suited for the production of various types of nursery stock now shipped from abroad. Assistance will be rendered in introducing small lots of stock for propagating purposes and in the general encouragement of the industry of growing stocks in this country. Improved methods for the propagation and handling of various types of nursery stock will be developed.

*Cooperation.*—Federal Horticultural Board; special collaborators at home and abroad.

*Location.*—Washington, D. C., and the several plant-introduction field stations, notably Chico, Cal., and Yarrow, Md.

*Date begun.*—1918.

*Assignment.*—David Fairchild, P. H. Dorsett, B. T. Galloway, Peter Bisset.

*Proposed expenditure 1918-19.*—Included in allotments for field stations.



**Minor Plant Introductions:**

*Object.*—To introduce, propagate, and distribute seeds and plants other than those covered in specific projects. This project covers improved or untested forms of the following: Feijoa, loquat, carissa, guava, pears, peaches, and cherries, *Prunus* stocks, wild relatives of economic plants for breeders, and the jaboticaba and other Brazilian fruits.

*Procedure.*—Seeds, plants, and plant material deemed of sufficient value to warrant their addition to those already grown in this country are introduced, propagated, and distributed.

*Cooperation.*—State experiment stations, parks, and other domestic institutions, and private individuals and cooperators.

*Location.*—Washington, D. C., and plant-introduction field stations.

*Date begun.*—1910.

*Results.*—A great quantity of miscellaneous seeds and plants has been introduced, propagated, and distributed, and preliminary readings as to hardiness have been obtained on a large number of valuable new fruit trees and shrubs.

*Assignment.*—David Fairchild, P. H. Dorsett, Peter Bisset.

*Proposed expenditures, 1918-19.*—\$1,500.

**Total, Plant-Introduction Field Investigations, \$63,400, including \$15,360 statutory.**

**Total, Foreign Seed and Plant Introduction, \$129,100, including \$37,660 statutory.**

[Research.]

**FORAGE-CROP INVESTIGATIONS.****SUPERVISION.****Supervision:**

*Object.*—To supervise the investigational work in connection with forage-crop production and perform administrative and routine clerical work incidental thereto.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—C. V. Piper.

*Proposed expenditures, 1918-19.*—\$18,320, including \$5,320 statutory.

**ALFALFA INVESTIGATIONS.****Alfalfa Investigations:**

*Object.*—To test and develop by breeding and selection and to establish new varieties of alfalfa, especially hardy and drought-resistant strains suitable for the Northwest, and to extend the profitable culture of alfalfa in the East.

*Procedure.*—In conducting these investigations, a definite plan has been adopted so that the same methods can be followed at the various points where the work is being done. Sufficient replication is done and enough checks are employed to make the results dependable. No experiments are outlined unless the results sought may answer problems of definite agronomic importance. The factors which determine the work to be done are the immediate needs of the section and the adaptability of the section to the solution of the problem.

*Cooperation.*—Colorado, Montana, Kansas, and Texas experiment stations and private individuals in the East.

*Location.*—Redfield, S. Dak., Moccasin and Havre, Mont., Aberdeen, Idaho, Rocky Ford, Colo., Chico, Cal., Hays, Kans., Amarillo and Chillicothe, Tex., and various points in Pennsylvania, New Jersey, Delaware, Maryland, Virginia, and North Carolina.

*Date begun.*—1915.

*Results.*—Results of the past season's work in alfalfa investigations indicate the effect of cutting on winter mortality. Results from plat tests indicate that late cutting is responsible to a considerable degree for winter killing and that, unless alfalfa plants have had an opportunity to recover well after cutting, there is great danger that they will not survive the following winter. The effect of a number of cuttings per season and the time of cuttings are being very closely studied on the plats at

Redfield, S. Dak. From the long-time cultural experiments with alfalfa conducted at Redfield, S. Dak., Moccasin and Havre, Mont., and Hays, Kans., data have been accumulated for later consideration.

Critical studies are being conducted throughout the West in connection with seed setting of alfalfa, especial attention being given to the study of the germination of alfalfa pollen grains. It has been found that germination of alfalfa pollen grains is very easily influenced, and the intention is to study this subject carefully for the light it may throw on seed setting.

Grafts of Peruvian alfalfa root and crown and of Grimm alfalfa root and crown were made last year and some plants transplanted to Redfield, S. Dak., to study their hardiness. These studies will be continued.

Some interesting observations have been made in connection with alfalfa yellows in the East. It appears that hybrids of Peruvian alfalfa and yellow-flowered alfalfa are immune to this trouble. Effort is now being made to increase stocks of seed of some of these hybrids with the view of giving them a thorough field test in the East under adverse conditions.

The following publications have been issued under this project since its inception: Farmers' Bulletins—339, "Alfalfa"; 495, "Alfalfa Seed Production"; and 757, "Commercial Varieties of Alfalfa"; Bureau of Plant Industry Circular 24, "Alfalfa in Cultivated Rows for Seed Production in Semiarid Regions"; and Department Bulletins—75, "Alfalfa Seed Production: Pollination Studies," and 428, "Medicago Falcata: A Yellow-Flowered Alfalfa."

*Assignment.*—R. A. Oakley, H. L. Westover, Samuel Garver, Leroy Moomaw. *Proposed expenditures, 1918-19.*—\$10,000.

#### CLOVER INVESTIGATIONS.

##### Clover Investigations:

*Object.*—To develop by breeding and selection hardy, heavy-yielding strains of clover with desirable seed and forage qualities; to determine the relative merits of various species of clover and cloverlike plants; to ascertain the causes and means of overcoming clover failures; and to improve the present methods of clover-seed production.

*Procedure.*—The relative merits of the different sorts of clover are studied more in detail at cooperative testing stations located at regular State experiment stations. The most promising of these strains are then put out in larger plat and field tests with suitably located cooperative farmers. The cultural requirements of clover are determined in a preliminary way from a large number of experimental plats at the cooperating experiment station and by pot experiments in the department laboratories. The most promising treatments are then tried out on a larger scale in the field. The factors which underlie successful seed production are determined in part by a field study of all the harvested seed yields in a given community as compared with the seed failures in the same community, to determine the different methods of treatment and to learn from this study the conditions presented in common by the fields giving the best yields of seed. The work of breeding improved strains of clover is carried out by selecting the most promising individuals from the variety-testing plats and comparing them with individual selections in the various clover fields.

*Cooperation.*—Indiana, North Dakota, and Wisconsin experiment stations and individual farmers throughout the northern and eastern parts of the United States.

*Location.*—Lafayette, Ind., Fargo, N. Dak., Ashland, Wis., North Ridgeville, Ohio, Arlington Farm, Va., and various points throughout the United States.

*Date begun.*—1905.

*Results.*—Pollination and seed-production studies have been conducted for the past two years with sweet clover. Self-pollination has proved to be almost as effective as cross-pollination in fertilizing flowers. About 50 species of insects which work on sweet clover have been collected and identified. The factors which influence the yield of sweet-clover seed were studied in detail and found to be largely a matter of the proper supply of moisture from the time the flowers open until the seed is nearly mature. Sweet clover is more drought resistant than most plants,



but requires considerable moisture for maturing seed, and unless this is supplied the maturing pods will abort.

Efforts are also being made to select a strain of crimson clover that will be hardy enough for use on the sandy lands of lower western Michigan. Experience has shown that crimson clover will sometimes succeed and is then very valuable, but it is not reliably hardy. This work is being carried on by means of selection experiments, the seed used being raised in northern Ohio and that in its turn coming from a hardy strain grown in Massachusetts.

The collecting of data on the causes of clover failure and the remedy therefor has been continued, and experimental work has been instituted to try out promising methods. The fact that lime and better cultural methods will go far toward improving the condition of the clover stand has been brought out even more strongly than before.

A detailed study has been made of the culture of lespedeza and much valuable information collected in regard to the methods of seeding, pasturing, handling, and marketing the hay. It has been found that most farmers do not cut the hay crop soon enough to produce the best quality of hay. The cutting of the hay after it has passed the proper stage and the presence of weeds have been the principal factors in preventing lespedeza from having the place on the market that it deserves.

Specific experiments have been conducted on the factors influencing clover-seed production. It has been found that excessive moisture in the soil is not injurious to the production of red-clover seed. Experiments are also being carried on to determine the length of time alsike and red-clover seed can endure flooding, as this is an important factor in the use of these crops on low-lying river-bottom lands. A series of experiments is also under way to determine the relative importance of the soil or the climate in the production of a maximum crop of red clover.

Pot-culture experiments on a soil on which red clover could not be grown were carried out in cooperation with the Office of Soil Fertility. It has been found that on such a soil the turning under of green manures aided materially in securing a satisfactory growth. Field experiments along this line have been instituted in cooperation with the Indiana Experiment Station.

An experiment is being carried on in cooperation with the Wisconsin Experiment Station to determine the effect of the continuous growing of red clover upon a good soil. The experiment involves the removal of the hay crop and the turning under of the remainder each year on a number of the plats and continuously turning under all of the growth upon other plats.

The following bulletins have been published on clovers: Farmers' Bulletins—455, "Red Clover"; 550, "Crimson Clover: Growing the Crop"; 579, "Crimson Clover: Utilization"; and 646, "Crimson Clover: Seed Production"; 797, "Sweet Clover: Growing the Crop"; 820, "Sweet Clover: Utilization"; and 836, "Sweet Clover: Harvesting and Thrashing the Seed Crop"; Department Bulletin 289, "Red-Clover Seed Production: Pollination Studies"; also an office circular entitled "A Rotary Seed Harvester for Crimson Clover."

*Probable date of completion.*—1920.

*Assignment.*—A. J. Pieters, H. S. Coe.

*Proposed expenditures, 1918-19.*—\$9,000, including \$1,200 statutory.

#### GRASS INVESTIGATIONS.

##### Pasture Investigations:

*Object.*—To determine the best methods of handling pastures so as to secure the maximum carrying capacity.

*Procedure.*—Tests of the different pasture plants are being made in cooperation with the Tennessee Experiment Station. These experiments are being conducted at Knoxville, Crossville, and Tullahoma, Tenn. The experiments at Crossville deal mainly with the matter of getting a stand of pasture plants on the cut-over lands of the Cumberland Plateau. Seedings were made with and without lime and fertilizers and with various methods of preparing a seed bed. A study of forage crops for hogs is also being made.

*Location.*—Tennessee and other States east of the Mississippi River.

*Date begun.*—1908.

*Results.*—A Farmers' Bulletin written in cooperation with the Animal Husbandry Division of the Bureau of Animal Industry, entitled "Hog Pastures for the Southern States," has been completed and is now in course of publication. The experimental work which has been carried on in cooperation with the Virginia Experiment Station for the past 10 years has been discontinued on account of losing control of the land which was leased by that station. A bulletin covering the results of that work is being prepared.

*Probable date of completion.*—1920.

*Assignment.*—Lyman Carrier.

*Proposed expenditures, 1918-19.*—\$3,600.

#### **Rhodes Grass:**

*Object.*—To determine the agronomic value of this recently introduced foreign grass.

*Procedure.*—Investigations are being conducted along the line of cultural treatment, including cultivation and the use of fertilizers.

*Cooperation.*—Many of the experiment stations are carrying out plot work on plans prepared by the department.

*Location.*—The cotton-growing States and Arlington Farm, Va. Most of the work is conducted in Florida and Texas.

*Date begun.*—1910.

*Results.*—Rhodes grass is gaining in popularity in Florida and promises to hold an important position among the forage crops of that State, especially for the better types of soil. In south Texas Rhodes grass has proved a great acquisition and has been planted in large acreages. Especial efforts are being made to develop in this State sources of seed supply.

A bulletin on the grass is in course of preparation.

*Probable date of completion.*—1920.

*Assignment.*—C. V. Piper.

*Proposed expenditures, 1918-19.*—\$500.

#### **Timothy Breeding:**

*Object.*—To secure by selection and breeding improved strains of timothy and to establish them agriculturally.

*Procedure.*—Selections have been made of different types of plants growing under different conditions in various parts of the country. These are tested in row plats in which plants propagated by seed and also plants propagated vegetatively from the original selection are grown. Many of the selections do not breed true to type from the seed, but occasionally one is found which does. Seed is saved of those which breed true, provided it is a desirable type and gives promise of being of agricultural value, and this seed is planted in increase plats. After it has been determined which are the most valuable selections, the stock of seed of these is increased to be distributed among farmers for further testing.

*Cooperation.*—Ohio Experiment Station.

*Location.*—North Ridgeville, Ohio.

*Date begun.*—1915.

*Results.*—A large number of selections have been made and tested out. The seed of a few of the most promising has now been increased in sufficient quantity that farm tests are being made of it. A study of the effect on wheat of seeding timothy with it in the fall and in the spring is being made, and a bulletin on this is in course of preparation. A manuscript entitled "Timothy" has been prepared for publication.

*Assignment.*—R. A. Oakley, M. W. Evans.

*Proposed expenditures, 1918-19.*—\$3,500.

**Total, Grass Investigations, \$7,600.**

#### **DRY-LAND FORAGE-CROP INVESTIGATIONS.**

##### **Field Pea:**

*Object.*—To determine the varietal adaptations, agronomic value, and climatic limitations of this crop, discover the best methods for its culture and utilization, increase its value and usefulness through the introduction and breeding of new varieties, and extend its use in localities where conditions warrant.



*Procedure.*—Rather extensive variety tests have been conducted at a number of field stations and in cooperation with several State experiment stations. Methods of culture are investigated at a few selected points, and farm practices in regard to the utilization of the field pea as a pasture plant are being studied in the San Luis Valley of Colorado, and their utilization for green manure in California and Texas.

*Cooperation.*—Montana and Idaho experiment stations; temporary cooperation with the Minnesota, Wisconsin, Michigan, and New York (Cornell) experiment stations.

*Location.*—Moccasin and Havre, Mont., Aberdeen, Idaho, Redfield, S. Dak., Waterville, Wash., and San Antonio, Tex.

*Date begun.*—1907.

*Results.*—The general testing of this crop has been very nearly finished. The regions of adaptability, methods of culture, and value in farming systems are discussed in Farmers' Bulletin 690. Three new varieties have been placed in the hands of farmers and are proving of considerable value. Earlier publications concerning this crops include Bureau of Plant Industry Bulletin 190, Bureau of Plant Industry Circular 106, and Washington Experiment Station Bulletin 99.

*Assignment.*—H. N. Vinall, Norval F. Woodward.

*Proposed expenditures, 1918-19.*—\$800.

### **Sorghum Investigations:**

*Object.*—To determine the best methods of culture, test promising imported varieties, breed strains better adapted to local conditions, and determine the silage value of sorghums as compared with corn and other crops.

*Procedure.*—Investigations are conducted at the various stations to ascertain the best methods of culture and to try out new and promising varieties. Experiments are also conducted with reliable farmers.

*Cooperation.*—Texas and Kansas experiment stations.

*Location.*—Arlington, Va., Chillicothe, Tex., Hays, Kans., Redfield, S. Dak., and Bard and Chula Vista, Cal.

*Date begun.*—1905.

*Results.*—Data published in Farmers' Bulletin 458, Department Bulletin 383, Bureau of Plant Industry Circular 122, and an article for the Journal of Agricultural Research entitled "Effect of Temperature and Other Meteorological Factors on the Growth of Sorghums." Progress has been made in the selection and breeding of improved varieties and in the study of inheritance of characters in the sorghums.

*Assignment.*—H. N. Vinall, A. B. Cron, R. E. Getty, H. R. Reed.

*Proposed expenditures, 1918-19.*—\$7,200.

### **Dry-Land Forage Crops Other than Sorghums:**

*Object.*—To test all forage crops believed to be of value in dry-land agriculture, improve standard crops by breeding, and determine the best cultural methods for such crops.

*Procedure.*—Row and plat tests, in case of new crops, and variety trials are followed by field tests of the most promising sorts. After this second elimination, those proving valuable will be given cooperative demonstration tests with farmers. Seed production, methods of cultivation, and combinations of legumes and nonlegumes are points of special study.

*Cooperation.*—Texas, Oregon, Washington, and Kansas experiment stations, and individual farmers throughout the Great Plains area.

*Location.*—Hays, Kans., Chillicothe, Tex., Moccasin and Havre, Mont., Waterville, Wash., Bard, Cal., and Moro, Oreg.

*Date begun.*—1908.

*Results.*—The value of a large number of miscellaneous forage crops reputed to be of value in dry regions has been determined. Special attention has been paid to the millets and field peas, and recommendations regarding the use of these crops have been made available to the public in Farmers' Bulletins 690 (millets) and 793 (field peas). Certain species of Agropyron introduced from Russia are doing well as pasture and hay grasses in the northern Great Plains. Additional data are to be found in Bureau of Plant Industry Circular 80 and Farmers' Bulletin 101.

*Assignment.*—H. N. Vinall, A. B. Cron, R. E. Getty, H. R. Reed, C. E. Hill, Norval F. Woodward.

*Proposed expenditures, 1918-19.*—\$8,100.

**Sudan Grass:**

*Object.*—To determine the agronomic value and climatic limitations of this grass and to develop disease-resistant strains.

*Procedure.*—Plat tests, designed to indicate its yielding power and the best methods of culture, are conducted on all the forage-crop field stations in the Great Plains and also in cooperation with numerous State experiment stations which, on account of their interest in Sudan grass, have volunteered to conduct a series of experiments outlined by the Office of Forage-Crop Investigations. Many field tests are also carried out by individual farmers under the direction of this office. Sudan grass has now become thoroughly established in the agriculture of the area to which it is best adapted. There yet remain large possibilities in the breeding of improved varieties.

*Cooperation.*—Temporary cooperation with certain State experiment stations and with a large number of farmers and agricultural organizations.

*Location.*—Arlington Farm, Va., Madison, Wis., Athens, Ga., Gainesville, Fla., Columbia, Mo., Chillicothe, Tex., Hays, Kans., Redfield, S. Dak., Moccasin and Havre, Mont., Moro and Corvallis, Oreg., and Chico, Bard, and Davis, Cal.

*Date begun.*—1909.

*Results.*—The preliminary work of introduction has been completed. Sudan grass has been tested in all parts of the United States, including our island possessions, and its climatic limitations are fairly well established. The acreage now grown for hay and pasture is large in the southern Great Plains, the irrigated regions of the Southwest, and the South-eastern States. Its use as a catch crop in the central corn-belt States is also increasing. Data on this crop are available in Farmers' Bulletin 605 and Bureau of Plant Industry Circular 125. The manuscript for a more comprehensive Department Bulletin is nearly ready for publication.

*Assignment.*—H. N. Vinall, A. B. Cron, R. E. Getty, S. Garver.

*Proposed expenditures, 1918-19.*—\$1,000.

**Total, Dry-Land Forage-Crop Investigations, \$17,100, including \$1,200 statutory.**

**MISCELLANEOUS FORAGE-CROP INVESTIGATIONS.****Cowpeas:**

*Object.*—To test and select new and improved varieties for seed, forage, and edible purposes throughout the Southern and Southwestern States; to breed varieties resistant to wilt and nematode; and to investigate the best methods of culture and of harvesting and thrashing the seed.

*Procedure.*—New introductions, selections, and hybrids are tested at Arlington Farm, Va., in comparison with the old standard varieties. Those varieties showing points of superiority over the old sorts are next tried out in variety tests with the experiment stations in the South. The most promising of these are then grown on a field scale to secure seed for more general distribution. Hybrids are made between varieties showing promising characters, such as white edible peas, high seed and forage yield, earliness, and disease resistance.

*Location.*—Arlington Farm, Va., Monetta, S. C., Rocky Mount, N. C., Baton Rouge, La., Knoxville, Tenn., Chula Vista and Chico, Cal., and Gainesville, Fla.

*Date begun.*—1905.

*Results.*—Farmers' Bulletin 318, Bureau of Plant Industry Bulletin 229, Bureau of Plant Industry Circular 119, and special leaflets have been published. A Farmers' Bulletin entitled "Cowpeas: Culture and Uses" is now being prepared.

A large amount of work has been carried on with new introductions, selections, and hybrids of this crop. Hybrids with either Iron or Brabham as one of the parents have given much promise as highly resistant strains of high forage and seed production in the wilt and nematode lands of the South. Several pure selections have been secured from Groit-Brabham crosses, which have given in field trials very promising results in yield of forage and seed on wilt and nematode-infested soils. Hybrids have been obtained between nearly all the standard varieties with other promising sorts and some promising pure strains secured. The Arlington, Columbia, and Potomac varieties, all the result of hy-



bridization, were tested on a field scale the past season and show sufficient promise for a general distribution.

A large collection of White and Blackeye varieties was tested out in the Blackeye-pea section of California during the past season, and a few show considerable promise over the common sort generally grown.

Extensive investigations have been conducted in North Carolina, Louisiana, California, South Carolina, and Florida, and at Arlington Farm, Va., relative to methods of culture, variety tests, rate of seeding, and dates of planting. Extension work has been continued with the Groit, Brabham, Early Buff, Early Catjang, and Monetta varieties. The Groit has proved a very desirable sort, both for hay and seed, throughout the cowpea region and in many sections of the corn belt. The Early Buff has given very good results not only in the Southern States but in several sections of the Central and Northern States for early forage and seed. The Brabham has become a well-established variety, especially suited for the wilt and nematode lands in the semiarid regions and in sandy soils. The Monetta has given quite good results in forage and seed and has proved highly resistant to wilt and nematode.

*Probable date of completion.*—1920.

*Assignment.*—W. J. Morse.

*Proposed expenditures, 1918-19.*—\$3,000.

### Soy Beans:

*Object.*—To extend the culture of soy beans in new sections; to ascertain the most valuable of the numerous varieties and determine their adaptability; to obtain new and improved varieties by hybridizing, selection, and introduction; to determine the best methods of culture and harvesting; and to bring about an increased use of soy beans not only for forage but for the production of oil and meal and for human food.

*Procedure.*—The new introductions, selections, and hybrids are tested at Arlington Farm, Va., in comparison with the leading commercial sorts for forage and seed yields, percentages of oil and protein, and their value for food. Those varieties showing qualities superior to the standard sorts are tested out in cooperation with State experiment stations. The most promising of these sorts are assigned varietal names and grown on a field scale so that large quantities of seed may be obtained for more general distribution.

*Cooperation.*—Variety, method of culture, and rate of seeding tests with the North Carolina, Missouri, and Louisiana experiment stations; extensive variety tests with nearly all the State experiment stations, and small field variety tests with reliable cooperators and county agents in different sections of the country.

*Location.*—Arlington Farm, Va., Monetta, S. C., Biloxi, Miss., Chula Vista, Bard, and Chico, Cal., Redfield, S. Dak., and North Ridgeville, Ohio.

*Date begun.*—1905.

*Results.*—Publications issued: Farmers' Bulletins—372, "Soy Beans"; 886, "Harvesting Soy-Bean Seed"; and 973, "Soy Beans: Culture and Uses"; Bureau of Plant Industry Bulletin 197, "Soy Beans: History, Varieties, and Field Studies"; special leaflet, "Soy Beans in the Cotton Belt"; Department Bulletin 439, "The Soy Bean with special Reference to Its Utilization for Oil, Cake, and Other Products"; and Department Yearbook (1917) article, "The Soy-Bean Industry in the United States." Other publications on the uses of the soy bean are in course of preparation. Extensive work in variety testing, selection, hybridization, and methods of culture and harvesting, utilization, and extension has been conducted. During the past season about 1,000 introductions, selections, and hybrids were tested out at Arlington Farm, Va. About 50 of the most promising varieties of the 1915 and 1916 trials were tested out throughout the Southern States for yields of seed and forage and to determine the effect of environment on the protein and oil content. Tests were continued with 30 of the most promising sorts obtained from northern Manchuria in all of the northern, central, and northwestern States. Several of these have given most excellent results as early maturing sorts of high grain yield and will be assigned varietal names for the present season's work.

Variety tests on the wilt and nematode lands of the South have given some varieties highly resistant to these diseases. The breeding work.



including selection and hybridization, has given some promising results. The most important commercial sorts have been crossed with a smooth nonshattering Japanese variety, and it is hoped that promising non-shattering sorts can be secured. Some of the varieties produced from breeding work and now on the market are Wilson-Five, Peking, Lexington, and Virginia.

In addition to the forage value, extensive investigations have been made as to the protein and oil value of the numerous introductions and selections and the effect of environment on these constituents in different parts of the country. Varieties have been found showing an oil content ranging from 12 to 25 per cent and a protein content from 30 to 46 per cent. Large quantities of imported seed were crushed for oil and meal by the cotton oil mills of the South during the season.

Recommendations for the use of the dry beans for food have resulted in the canning of large quantities of domestic-grown beans and also their establishment on the market as a dried edible bean. Many food products are now being prepared in the United States from the soy bean and its products, such as soy sauce, breakfast foods, flour and meal, lard and butter substitutes, bean cheese, baked beans and canned green beans. The increased utilization of the soy bean for human food, forage, and the production of oil and meal has resulted in a greatly increased acreage and has made the production of seed a very profitable industry. Indications are that the acreage will be greatly increased the present season for forage and seed.

The extension work has been principally with the Manchu, Black Eyebrow, Biloxi, Tokio, Haberlandt, Wilson-Five, Peking, and Virginia varieties. The Manchu and Black Eyebrow varieties have been found especially promising in the Northern States, both for forage and grain. The Biloxi has given excellent results in the southern part of the Gulf States on rice lands. The Haberlandt is an excellent bean for food and has given very good results in the Southern and Central States. All the above varieties are now in the hands of growers and seedmen and have replaced nearly all the old commercial sorts.

*Probable date of completion.*—1920.

*Assignment.*—W. J. Morse.

*Proposed expenditures, 1918-19.*—\$5,800.

### **Velvet Beans:**

*Object.*—To compare different species of *Stizolobium* and obtain new varieties by breeding, especially with the object of securing a bushy variety.

*Procedure.*—Promising new and improved varieties of velvet beans are tested at the various testing stations, and varieties that prove their worth are propagated and distributed throughout the South.

*Cooperation.*—Florida Experiment Station.

*Location.*—Biloxi, Miss., and Brookville and Miami, Fla.

*Date begun.*—1905.

*Results.*—The Chinese velvet bean has met with favor throughout the South and is superior to any of the hybrids thus far developed with the exception of the Osceola. The Osceola velvet bean is rapidly becoming popular in many sections, and it is believed that this variety will be largely grown in the southern half of the Gulf States. It has the same objectional feature as the Chinese variety in that the pods split and shatter somewhat after they have become fully mature. The history of the origin of the Georgia and Alabama varieties of velvet beans has been collected and will be published in a short time. These two varieties resemble the Florida in all characters except date of maturity, the Georgia maturing in about 120 days and the Alabama in about 150 days. Farmers' Bulletin 962, "Velvet Beans," has been issued.

*Probable date of completion.*—1920.

*Assignment.*—S. M. Tracy, H. S. Coe.

*Proposed expenditures, 1918-19.*—\$2,000.

### **Vetches:**

*Object.*—To test all the different varieties of this crop and to breed improved strains.

*Procedure.*—Breeding work is conducted, experiments made with different varieties to ascertain their value, and methods of culture studied.

*Cooperation.*—Oregon Experiment Station.



*Location.*—Chico, Cal., Corvallis, Oreg., Arlington Farm Va., Waterville, Wash., and Biloxi, Miss.

*Date begun.*—1905.

*Results.*—The testing and study of the many species and varieties of vetch in various parts of the country has been continued and the extended use of the common and the hairy vetch encouraged. The results of the year's work confirm the conclusions of previous years as to the superior value of purple vetch for green-manuring in the southwestern United States and that seed can be grown cheaply, especially in Oregon and Washington west of the Cascade Mountains.

Bitter vetch has continued to do well in parts of California, and efforts are being made to determine the possibilities of producing the seed commercially.

The study of the production of Tangier-pea seed has been continued. The seed habits of this crop are poor, and the high cost of production of seed is the principal factor preventing its more extended use.

Woolly-podded vetch has done well in the southeastern United States and promises to be of superior value for this section. This species and Hungarian vetch are more winter-hardy than common vetch and can be used farther north than that species, though not as far north as the hairy vetch. The Hungarian vetch gives promise of being especially adapted to lands too wet for other vetches. A strain of narrow-leaf vetch with non-shattering seed has been developed and seed is being increased for experimental tests. If this proves as valuable in other ways as the common strain of this vetch, which has very poor seed habits, it will be of great value in the northeastern United States, where narrow-leaf vetch is very valuable for winter pasturage.

Increased interest in vetches throughout the country shows a better appreciation of the value of this crop and indicates the possibilities of a more extended use.

Data are published in Farmers' Bulletins—515, "Vetches" (a revision now in press); 529, "Vetch Growing in South Atlantic States"; and 967, "Purple Vetch"; Bureau of Plant Industry Circular 102, "The Production of Hairy Vetch Seed"; Bureau of Plant Industry Bulletin 190, "Orchard Green-Manure Crops in California"; and a Farmers' Bulletin, now in press, entitled "Horse Beans."

*Probable date of completion.*—1920.

*Assignment.*—Roland McKee.

*Proposed expenditures, 1918-19.*—\$3,000.

**Total, Miscellaneous Forage-Crop Investigations,** \$13,800, including \$1,000 statutory.

#### NEW FORAGE CROPS.

##### New Forage Crops:

*Object.*—To test new grasses and legumes of probable forage value.

*Procedure.*—Various forage plants of possible forage value are tested in the field in rows and plats, and such as possess promise are thoroughly tried out.

*Cooperation.*—Various State experiment stations.

*Location.*—Arlington Farm, Va., Chico, Cal., Biloxi, Miss., and various experiment stations.

*Date begun.*—1906.

*Results.*—From the studies carried on under this project there has resulted the introduction of a number of valuable new forage crops, including Sudan grass, giant Bermuda grass, Carib grass, Napier grass, Kikuyu grass, blue couch grass, *Paspalum notatum*, and Toda grass. On muck lands in Florida, Carib grass, an introduction from Brazil, has out-yielded by about 50 per cent Para grass, the best grass previously known for such conditions. Napier grass, a recent introduction from Africa, has proven a great acquisition to Florida and southern California. Kikuyu grass, also from Africa, is giving splendid promise in Florida.

Much agronomic information has also been secured concerning such legumes as kudza, hyacinth beans, jack beans, algaroba, mung beans, adsuki beans, and others.

The following publications have been issued: Department Bulletins—318, "The Bonavist, Lablab, or Hyacinth Bean," and 119, "Five Oriental Species of Beans"; and Bureau of Plant Industry Circular 110, "The Jack Bean and the Sword Bean."

*Assignment.*—C. V. Piper, W. J. Morse, S. M. Tracy.

*Proposed expenditures, 1918-19.*—\$4,580.

## RANGE AND DRY-LAND PASTURE INVESTIGATIONS.

**Range and Dry-Land Pasture Investigations:**

*Object.*—To improve the carrying capacity of pastures in the dry-land region and of natural ranges, especially by the introduction of well-adapted grasses and legumes and by better cultural and management methods.

*Procedure.*—Cultural experiments are conducted on pastures in dry-land regions, and plants that promise to increase natural pasturage on range lands are introduced, tested, and distributed.

*Cooperation.*—Washington and Oregon experiment stations.

*Location.*—Waterville, Wash., Havre, Mont., Chillicothe, Tex., Chico, Cal., Hays, Kans., and Moro, Oreg.

*Date begun.*—1902.

*Results.*—The following publications have been issued: Bureau of Plant Industry Bulletins—4 "Range Improvement in Arizona"; 15, "Forage Conditions on the Northern Border of the Great Basin"; 38, "Forage Conditions and Problems in Eastern Washington, Eastern Oregon, Northwestern California, and Northwestern Nevada"; 67, "Range Investigations in Arizona"; and 117, "The Reseeding of Depleted Range and Native Pastures"; and Department Bulletins—201, "Native Pasture Grasses of the United States," and 211, "Factors Affecting Range Management in New Mexico." In press: Professional Paper, "The Salt Bushes and Their Allies as Range Forage Plants."

*Assignment.*—C. V. Piper, R. A. Oakley, Lyman Carrier.

*Proposed expenditures, 1918-19.*—\$4,000.

(Cactus Investigations: Work under this project has been temporarily discontinued and the funds transferred to other more pressing lines of work.)

## WEED INVESTIGATIONS.

**Weed Investigations:**

*Object.*—To determine the most practical and efficient method of controlling and eradicating weeds.

*Procedure.*—Field studies and experiments are conducted.

*Location.*—Headquarters, Washington, D. C.; investigations conducted in various localities throughout the United States.

*Cooperation.*—Individual farmers in Illinois, Indiana, Kentucky, Maine, New Hampshire, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, Connecticut, North Carolina, South Carolina, Texas, and Virginia.

*Date begun.*—1905.

*Results.*—These investigations have been mainly concerned with finding practical methods of eradicating the most troublesome of the weed species. These findings have been published in bulletin form, in circulars, and in news articles, and the methods recommended have been of practical benefit.

Cooperative experiments, conducted since 1906 in 27 States, have shown that the principal object of intertillage is to control weeds and that, if weeds are eliminated, intertillage is of minor importance; therefore, intertillage should be planned especially to the end of controlling weeds.

Prior to 1917 investigations were made of tillage practices, and the results have been published in bulletin form showing the actual tillage practices employed in growing corn and cotton in the areas where these crops are most extensively produced.

Investigations of herbicides have been in progress for seven years in eight States, and much detailed information is being gradually accumulated. A particular effort is being made to ascertain the limitations of this method of weed control.

An extensive investigation of nut grass, *Cyperus rotundus*, has been undertaken in the Southern States, including field experiments and studies of farm practice throughout the southern coastal States and Arkansas.

Investigations of pasture weeds have been continued, this work being conducted in all the Eastern States and in cooperation with five State experiment stations. These studies include field experiments with each of the bad pasture weeds.



During the past year a Department Yearbook article on "The Weed Problem in American Agriculture" was prepared, as well as Farmers' Bulletins on Canada thistle (*Cirsium arvense*) and Bermuda grass (*Cynodon dactylon*). An illustrated lecture on "Weed Control" and a number of news articles and circulars have also been prepared. The following publications have been issued: Bureau of Plant Industry Document 416, "The Wild Onion"; Bureau of Plant Industry Circular 94, "The Mangum Terrace in Its Relation to Efficient Farm Management"; Bureau of Plant Industry Bulletin 257, "The Weed Factor in the Cultivation of Corn"; Farmers' Bulletins—279, "A Method of Eradicating Johnson Grass"; 368, "The Eradication of Bind Weed or Wild Morning Glory"; 464, "The Eradication of Quack Grass"; 545, "Controlling Canada Thistles"; 610, "The Wild Onion: Methods of Eradication"; 660, "Weeds: How to Control Them"; 687, "Eradication of Ferns from Pasture Lands in the Eastern United States"; and 833, "Methods of Controlling or Eradicating the Wild Oat in the Hard Spring-Wheat Area"; Department Bulletins—320, "Farm Practice in the Cultivation of Corn"; and 511, "Farm Practice in the Cultivation of Cotton"; and Department Yearbook (1917) article entitled "The Weed Problem in American Agriculture."

*Assignment.*—H. R. Cates, L. W. Kephart, A. A. Hansen.

*Proposed expenditures, 1918-19.*—\$7,500

**Total, Forage-Crop Investigations, \$91,900, including \$8,720 statutory.**

[Extension.]

## SEED DISTRIBUTION.

### SUPERVISION.

#### Supervision:

*Object.*—Supervision of administrative details relating to the purchase and distribution of vegetable, flower, cotton, tobacco, lawn-grass, and of new and rare field seeds, bulbs, and plants; handling congressional correspondence and franks; and supervision of the personnel of the office.

*Procedure.*—This work is carried on in three sections, one section of the office taking care of the details in connection with the purchase and distribution of vegetable, flower, tobacco, and lawn-grass seed and of bulbs; a second section taking care of the congressional correspondence in connection with the distribution of the vegetable, flower, and lawn-grass seed and of bulbs; and another section taking care of the details relating to the purchase and distribution of cotton and new and rare field seeds and the handling of the congressional correspondence in connection therewith.

*Location.*—Washington, D. C.

*Date begun.*—Distribution inaugurated in the Patent Office in 1839, transferred to the Division of Agriculture in the Interior Department in 1862, in 1888 transferred to the newly created Department of Agriculture, and in 1902 placed in the Bureau of Plant Industry.

*Assignment.*—R. A. Oakley.

*Proposed expenditures, 1918-19.*—\$25,455, including \$17,455 statutory.

### CONGRESSIONAL DISTRIBUTION.

#### Vegetable and Flower Seeds:

*Object.*—Purchasing, testing, packeting, franking, assembling, and mailing vegetable and flower seed for congressional distribution.

*Procedure.*—All seeds are purchased through competitive bids obtained from the principal seed growers and dealers in this and foreign countries. All purchases are made subject to satisfactory appearance, purity, germinability, and trueness to varietal name or type. The testing of samples of seed to ascertain its purity and germination is done by experts in the Seed-Testing Laboratory both before and after the shipment of the bulk seed. The seeds are packeted, assembled, and mailed under a private contract.

*Location.*—Washington, D. C.

*Date begun.*—Patent Office, 1839; Division of Agriculture, Interior Department, 1862; Department of Agriculture, 1888; Bureau of Plant Industry, 1902.

*Results.*—Standard varieties of vegetable and flower seeds of known value and of the best quality have been distributed. Data published in Bureau of Plant Industry Circular 100, "Distribution of Seeds and Plants by the Department of Agriculture." During the past fiscal year 13,000,000 packages of seed were distributed, including 10,500,000 packages of vegetable seed and 2,500,000 packages of flower seed.

*Assignment.*—R. A. Oakley, J. E. W. Tracy.

*Proposed expenditures, 1918-19.*—\$228,770.

### **Tobacco Seed:**

*Object.*—Purchasing, testing, packeting, franking, and mailing tobacco seed for congressional distribution.

*Procedure.*—The varieties of tobacco included in the distribution are selected by the Office of Tobacco Investigations.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Results.*—During the past year 300 packages of tobacco seed were distributed.

*Assignment.*—R. A. Oakley.

*Proposed expenditures, 1918-19.*—\$50.

### **Lawn-Grass Seed:**

*Object.*—Purchasing, testing, packeting, assembling, and mailing lawn-grass seed for congressional distribution.

*Procedure.*—All seed is purchased on competitive bids and, before acceptance, is tested for purity and germinability. For the South, Bermuda-grass seed is furnished for lawn making, while for the other sections of the country a mixture of Kentucky bluegrass, redtop, perennial rye-grass, and white clover is supplied. A circular giving full directions for making and maintaining a lawn accompanies each package of seed.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Results.*—During the past fiscal year 13,500 packages of lawn-grass seed were distributed.

*Assignment.*—R. A. Oakley.

*Proposed expenditures, 1918-19.*—\$2,500.

**(Strawberry Plants:** This project has been discontinued owing to inability to obtain suitable plants in sufficient quantity for distribution.)

### **Dutch Bulbs:**

*Object.*—Congressional distribution of Dutch bulbs.

*Procedure.*—Standard varieties of tulips and narcissus bulbs are usually purchased on competitive bids, principally from firms in Holland, and distributed on congressional requests. However, all the bulbs distributed during the fall of 1917 were grown at the department's bulb garden at Bellingham, Wash., and it is proposed to furnish Bellingham-grown bulbs for congressional distribution in the fall of 1918.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Results.*—During the past year 11,500 boxes of Dutch bulbs were distributed.

*Assignment.*—R. A. Oakley.

*Proposed expenditures, 1918-19.*—\$2,000.

### **Miscellaneous Seeds and Plants:**

*Object.*—Congressional distribution of miscellaneous seeds and plants.

*Procedure.*—Miscellaneous seeds and ornamental shrubs and plants are purchased on competitive bids and distributed on congressional requests.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Results.*—The direct result of this distribution has been to encourage the growing of ornamentals about the home.

*Assignment.*—R. A. Oakley.

*Proposed expenditures, 1918-19.*—\$2,000.



**Seed Cleaning:**

*Object.*—To remove impurities from seeds purchased for congressional distribution and to test seed-cleaning devices.

*Procedure.*—Improved modern seed-cleaning machines have been procured, together with a full equipment of screens. All vegetable, flower, and field seeds containing impurities are thoroughly cleaned before distribution. Experiments are being conducted in cleaning drug-plant, sugar-beet, and other seeds.

*Cooperation.*—Drug Inspection Laboratory. Bureau of Chemistry.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Results.*—Successful methods have been developed for cleaning senna and other drug-plant seeds and celery and sugar-beet seed. During the fiscal year 1918 large quantities of vegetable, flower, and field seeds were cleaned before being distributed by the department.

*Assignment.*—R. A. Oakley.

*Proposed expenditures 1918-19.*—\$1,500.

**Total, Congressional Distribution,** \$236,820, including \$9,400 statutory. This does not include \$6,900 allotted from the appropriation for the purchase and distribution of valuable seeds to Horticultural Investigations for carrying on the work under the projects "Standardization of Varieties of Vegetables through Selection" and "Vegetable History and Nomenclature."

#### PURCHASE AND DISTRIBUTION OF NEW AND RARE SEEDS.

**Purchase and Distribution of New and Rare Seeds:**

*Object.*—To disseminate new and rare high-grade seed of crops new to sections where the data of the department indicate such crops to be of considerable promise. Each package contains a sufficient quantity for a preliminary trial, and, where it is at all practicable, the recipient is urged to use the seed for the production of stocks for future plantings. It is believed that if this practice is followed consistently it will result in a material improvement in the crops of the country.

*Procedure.*—A list of new and rare seeds worthy of special distribution is prepared by the specialists of the bureau. The sources from which such seeds are obtainable and the quantity available for fall delivery are ascertained in advance. Senators and Representatives are advised of the kinds of seed available and suitable for distribution in their respective districts and are asked to submit a list of names of a number of reputable farmers in their districts who would be willing to plant and care for an area large enough to determine the cost of cultivating and harvesting the new crop in their section in conformity with plans outlined by the department. When the reports are received at the close of the season they are referred to the respective offices dealing with the particular crops involved for their information and for such follow-up work as they may deem advisable. The officer in charge of the distribution of new and rare field seeds is responsible for the finances and has charge of all matters involved in the purchase, propagation, testing, and distribution of these new and rare field seeds, but always in cooperation with and through the advice of crop specialists of the office interested in the particular crops involved. Each office of the bureau to which any crops included in the distribution belong prepares the necessary cultural directions and report blanks, indicates the quantity of seeds to be included in the package, and takes charge of such reports as may be received from growers.

*Location.*—Headquarters, Washington, D. C.; distribution throughout the United States.

*Date begun.*—1912.

*Results.*—This distribution has enabled farmers to procure seed of new and improved crops in sufficient quantities to produce similar stocks for future seeding, thus materially improving the crops of the country.

During the past fiscal year 245,000 packages of seed were distributed, comprising 150,000 packages of seed of new and rare forage crops and 95,000 packages of new and improved varieties of cotton. Each package contained a sufficient quantity for a preliminary trial, and the recipient



was urged to use the seed for the production of seed for future planting. Inclosed in each package of seed was a circular giving full directions for the planting and cultivating of the crop and a report card on which to submit a report to the department on the results obtained. Seed of the following-named crops was included in the distribution: Baltic, Dakota-grown, Grimm, Kansas-grown, Montana-grown, and Peruvian alfalfas; Brabham, Early Buff, and Groit cowpeas; feterita; Bangalia, French June, Carleton, Golden Vine, and Kaiser field peas; hegari; Dwarf Blackhull Kafir, Kursk, and Siberian millets; Natal grass; Rhodes grass; Dakota Amber, Honey, Red Amber, and Sumac sorghums; Biloxi, Black Eyebrow, Early Green, Ebony, Haberlandt, Hollybrook, Ito San, Mammoth Yellow, Manchu, Peking, Tokio, Virginia, Wilson, and Wilson-Five soy beans; Sudan grass; White and Yellow sweet clovers; Chinese, Early Georgia, and Osceola velvet beans; and Acala, Columbia, Dixie, Durango, Lone Star, and Trice varieties of cotton.

*Assignment.*—R. A. Oakley.

*Proposed expenditures, 1918-19.*—\$64,500, including \$4,500 statutory.

**Total, Seed Distribution,** \$326,775, including \$31,355 statutory.

[Extension.]

## DEMONSTRATIONS ON RECLAMATION PROJECTS.

### Supervision:

*Object.*—To supervise demonstration work on Government reclamation projects and to conduct office business in connection therewith.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Assignment.*—F. D. Farrell.

*Proposed expenditures, 1918-19.*—\$11,670.

### Field Demonstrations:

*Object.*—To encourage and aid settlers on Government reclamation projects in the development of local agricultural industries by supplying information, making suggestions, and conducting demonstrations relating to agricultural industries, and by assisting in the formation and conduct of farmers' cooperative organizations for the purpose of improving the methods of production and disposal.

*Procedure.*—Field representatives, under the supervision of the Washington office, stationed on the reclamation projects, operate in direct cooperation with the settlers in the furtherance of the objects outlined above. Close cooperation is had with the Office of Western Irrigation Agriculture in all the work. On those projects where that office maintains field stations and where this office has field men stationed, the two offices cooperate closely in placing before the farmers the results of the field investigations.

*Cooperation.*—United States Reclamation Service, Bureau of Animal Industry, Bureau of Markets, and State and local agencies interested in the agricultural development of the Government reclamation projects.

*Location.*—Arizona-California (Yuma project), Colorado (Uncompahgre project), Idaho (Boise and Minidoka projects), Montana (Huntley project), Nevada (Truckee-Carson project), Oregon (Umatilla project), South Dakota (Belle Fourche project), Washington (Yakima project), Wyoming (Shoshone project), and Nebraska-Wyoming (North Platte project).

*Date begun.*—1914.

*Results.*—During the fiscal year 1917 work was conducted on nine reclamation projects. The work accomplished during that fiscal year included the development of additional cooperative activity among project settlers in the manufacture and marketing of dairy products, in the control of animal diseases, in the use of grazing lands, and in the marketing of swine, poultry, and beef cattle. In addition to the development of these activities, educational work was done with reference to the more efficient use in live-stock industries of the forage and grain crops produced by the settlers, to an increased use of irrigated pastures, and to improved methods in the production of crops for use in supplementing alfalfa as a feed for live stock.



In the fiscal year 1918 the work conducted in 1917 was continued. The conditions resulting from the entry of this country into the war had a profound influence on the agriculture of the reclamation projects and resulted in much instability. In the work of this office efforts were directed toward the stabilization of the agricultural industries of the projects, special emphasis being placed upon the desirability of maintaining live-stock production. There were some instances in which the live-stock population decreased, due largely to the rise in the prices of feed. Reductions in the live-stock population, however, were confined largely to inferior animals, it being found necessary to eliminate many of these in the interest of efficiency. The economic pressure affecting the live-stock industries had, on the whole, many beneficial effects, as it hastened some desirable readjustments which heretofore were developing gradually and encouraged the development of more efficient practices. A few of the more important features of the work accomplished during the fiscal year 1918 are noted below:

On the North Platte project attention was given chiefly to the swine industry, but some preliminary work was done in connection with dairy farming. The principal features of the work with swine included improvements in methods of feeding and management, the further development of cooperative marketing, the control of swine diseases, the conduct of a large number of feeding tests in cooperation with farmers, and improvements in buildings and other equipment used in swine production. The principal preliminary work done in connection with the dairy industry included some surveys of the local dairy situation and the location of some dairy breeding stock.

The work on the Truckee-Carson project was devoted chiefly to dairying and swine production, but some attention was given to poultry and sheep. During the fiscal year 1918 the operation of a cow-testing association, organized the previous year, was continued, and this resulted in decided improvements in the quality of dairy stock. Betterments made during the year in equipment used by dairy farmers included the construction of 27 cow barns and 2 silos. The diseases which heretofore have caused serious losses, particularly contagious abortion, were much more effectively controlled than formerly and the losses were small. The principal work done with swine included the development of cooperative marketing, through which practically all the surplus hogs were disposed of. The farm-sheep industry, which is in its early stages of development, was encouraged, chiefly through assisting the settlers in developing satisfactory feeding methods and in locating and selecting breeding stock. The work in connection with the poultry industry was devoted largely to turkeys, in connection with which assistance was given in marketing and the control of diseases. In cooperation with the Office of Western Irrigation Agriculture, a number of successful tests of pasture grasses, silage crops, grain varieties and peas, and grain mixtures for hogging-off purposes were conducted.

On the Minidoka project the work involved swine production, dairying, beef production, and sheep production. Attention was again given to the control of hog cholera and other diseases of swine, and no serious disease losses occurred. Feeding tests conducted in cooperation with farmers demonstrated methods whereby swine can be finished for marketing without the feeding of wheat, as has heretofore been extensively practiced. In this connection special attention was paid to peas and mixtures of peas and small grains, and gains ranging from 800 to 950 pounds of pork per acre were made on these crops. The interest in sheep production on the farms was more marked than in any other live-stock industry. The number of farm flocks increased from 289 to 482. Assistance was given in connection with this industry in improving the breeding, feeding, and management methods and in the location and selection of breeding stock. In the latter connection, 147 pure-bred rams were selected for project sheep growers. Assistance was given in improving the equipment on 30 sheep-producing farms, two community shearing plants were placed in operation, and two herds of sheep utilized grazing lands in an adjacent national forest under the auspices of a cooperative grazing association. In order to assist in placing range sheep on farms for winter feeding and finishing, assistance was given in the location of 19,500 ewes, and arrangements were made whereby these could be purchased direct from



the rangemen at a saving to the farmers of approximately \$2 a head. During the year, Department Bulletin 573, "The Sheep Industry on the Minidoka Reclamation Project," was published. The principal work in connection with the beef industry had to do with the encouragement of cooperative grazing. Four cooperative herds were put on the range and satisfactory results obtained. Assistance was also given in the location and selection of improved breeding stock.

On the Yakima project, where the work is devoted chiefly to dairying, swine production, and beef production, satisfactory progress was made. A large number of improved dairy animals were located and selected for project farmers. A cow-testing association was operated successfully, and a campaign for increased use of silage resulted in the building of about 30 new silos. Preliminary work was done for the organization of a cooperative bull association. The methods of marketing dairy products were materially improved, partly through the establishment of a cooperative cheese factory and partly through improved methods of handling products disposed of at other markets. In connection with the swine industry, a number of successful feeding tests were conducted in cooperation with farmers, and the results are helpful in showing the high value of field peas and corn to be hogged-off. The cooperative grazing association, which each year grazes more than a thousand head of cattle on the adjoining national forest, had another successful year. Some effective work was done in the prevention of blackleg among range stock and in winter feeding.

The work on the Shoshone project had to do chiefly with dairying, swine production, sheep production, and the beef industry. Experimental pasture plantings were successfully made on 21 farms, well distributed throughout the project, in cooperation with the Office of Western Irrigation Agriculture. The work in cow testing and in the improvement of feeding methods was continued. In connection with the beef industry, two cooperative herds were sent to the adjacent ranges for the summer grazing period with satisfactory results. Cooperative marketing of beef cattle was successfully inaugurated, and its benefits were participated in by 168 farmers. Some cooperative swine-feeding tests were conducted, and the results are being used effectively in developing improved swine-feeding methods.

On the Huntley project the work involved dairying and swine production chiefly, but some attention was paid to sheep production. The interest in dairying continued to increase. Special attention was paid to herd improvement through the use of good bulls and through cow testing. Irrigated pasture plantings were made throughout the project, in cooperation with the Office of Western Irrigation Agriculture, and some very satisfactory results were secured. For the first time silage was fed on the project, two silos being built and filled. Interest in this work increased materially. Some attention was paid to securing breeding stock for small flocks of farm sheep and to feeding and the control of diseases among swine.

On the Uncompahgre project the work involved dairying, swine production, and the sheep and beef industries. There was a marked increase in dairying, as is evidenced by the fact that dairy stock were carried on 215 more farms in 1917 than in 1916. Assistance was given in the importation of 136 head of dairy stock, of which 22 were pure bred. The area of pastures increased from 1,936 to 2,240 acres. A special campaign to encourage the use of silage was carried on, and 29 new silos were built. The swine industry is rapidly becoming readjusted to a basis on which swine are being produced in smaller herds than heretofore. There was an increase in the number of farms carrying swine in 1917 as compared with 1916, although the total swine population on the project decreased. Swine-feeding tests were conducted on 7 farms. Cooperative marketing of hogs was encouraged, and this method is now almost universal on the project. A beginning was made in the production of small flocks of farm sheep. Assistance was given in the selection and importation of 480 pure-bred sheep for breeding purposes, and information and advice were furnished with reference to methods of feeding and management. The number of beef cattle on the project increased during the year about 14 per cent. The principal activities in this connection had to do with range utilization and the prevention of blackleg among range stock.



On the Boise project the work included dairying, swine production, beef production, and the sheep industry. There was an increase of 164 in the number of farms carrying dairy stock. The value of the butter fat marketed at local factories during the calendar year 1917 was about \$605,000. Special attention was paid to the development of more efficient feeding methods, with particular reference to the feeding of silage, and 30 new silos were constructed. A number of swine-feeding tests were conducted, special attention being paid to hogging-off forage crops, including field peas. The work of controlling swine diseases was continued, with excellent results. There were only 12 outbreaks of cholera during the year, and the losses from this cause were negligible. The principal activity in connection with the beef industry was the successful inauguration of a cooperative grazing association with 25 members, who grazed 700 head of cattle in the Boise National Forest for a period of 6 months at a total expense of \$3.12 per head for the season. There was increased interest in sheep production, as is indicated by the fact that the number of farms carrying sheep increased from 168 to 314. Assistance was given in the selection of breeding stock and in improving methods of feeding and management. A wool pool having 41 members was organized, and these farmers marketed their output of wool cooperatively at an expense of 0.8 cent per pound, the wool selling for 63 cents per pound.

On the Umatilla project work was conducted in irrigation and crop production, with special reference to the reclamation of the sandy lands of the project. In this work assistance was given to the settlers in planning and constructing farm irrigation systems on new lands and in the improvement of the systems already in operation. The results of this work are rapidly becoming apparent. There is a much increased use of better methods of preparing land and applying water, particularly with reference to the border system of irrigation, which is rapidly gaining in popularity.

*Assignment.*—Boise project, leader to be assigned; Huntley project, leader to be assigned; Minidoka project, leader to be assigned; North Platte project, George O. Unruh; Shoshone project, Don G. Magruder; Yakima project, Roy P. Bean; Truckee-Carson project, L. E. Cline; Uncompahgre project, H. A. Lindgren; Umatilla project, R. W. Allen; Yuma project, leader to be assigned; Belle Fourche project, E. H. Aicher.

*Proposed expenditures, 1918-19.*—\$38,330.

**Total, Demonstrations on Reclamation Projects, \$50,000, including \$1,400 statutory.**

## FOREST SERVICE.

### GENERAL ADMINISTRATION.

#### Forester:

*Object.*—Direction and control of all administrative and research activities of the Forest Service.

*Procedure.*—The administrative work of the Forest Service comprises (1) administration of the national forests, (2) purchase of lands on the watersheds of navigable streams, (3) protection of forested watersheds of navigable streams in cooperation with States, and (4) application of forestry to private timberlands. The research work comprises studies in dendrology, forestry, the utilization of forest products, and the most effective use and improvement of national-forest grazing lands. Preference is given to problems arising in the administration of the national forests, but the investigations also include the forest and allied interests of the country at large. The administrative work is conducted through seven branches at Washington—of Operation, Lands, Silviculture, Grazing, Research, Engineering, and Acquisition, respectively—each in charge of an assistant forester, with the exception of Operation, which is directly under the Forester, and of Engineering, which is under the Chief Engineer. While the bulk of national-forest business is transacted in the supervisors' and district offices, transactions of large importance and matters of policy are passed upon by the Forester. General control and uniformity in the application of policies are maintained through field inspection by the Forester and his staff of assistant foresters and forest inspectors.

*Location.*—Washington, D. C.

*Date begun.*—Division of Forestry organized as an administrative unit in 1881.

*Assignment.*—H. S. Graves, A. F. Potter, W. B. Greeley, E. A. Sherman, W. L. Hall.

*Proposed expenditures, 1918-19.*—\$22,862.

#### Accounts:

*Object.*—To receive and disburse the funds and keep the financial and appointment records of the Forest Service.

*Procedure.*—The Chief of the Office of Accounts at Washington has general charge of all fiscal matters pertaining to the Forest Service. Under his general direction the district fiscal agents receive and disburse money, keep financial and appointment records, and supervise the accounting work of the national forests in their respective districts. Periodical reports are made by them, and their quarterly accounts with the Treasury Department are transmitted through his office for examination and record. General accounts are kept in Washington covering all Forest Service appropriations and allotments to the several districts, while financial transactions in detail are kept by the district fiscal agents. Reports of receipts and expenditures received from all districts and branches of the Forest Service are verified and summary statements prepared monthly, and at other times when required, for the information of the Secretary, the Forester, chiefs of branches, and other officers of the Forest Service directly concerned. Cost statements and other compilations of financial data and annual reports of receipts and expenditures required by the Treasury Department, the Secretary of Agriculture, and by Congress are prepared from records and from district and forest reports.

*Location.*—Washington, D. C., and district headquarters.

*Date begun.*—1905; present organization established in 1908.

*Assignment.*—M. E. Fagan.

*Proposed expenditures, 1918-19.*—\$21,200.



**Law Work:**

*Object.*—Performance of all legal work on behalf of the Forest Service.

*Procedure.*—The Solicitor of the Department of Agriculture assigns from his office to each Forest Service district an assistant, who becomes a member of the executive force of the district, gives advice on legal matters to the district forester and his assistants, prepares contracts, leases, and other legal papers, and, subject to approval by the Solicitor, renders decisions on legal questions and institutes suits for trespass and other violations of national-forest laws.

*Cooperation.*—Department of Justice.

*Location.*—Washington, D. C., and district headquarters.

*Date begun.*—1903; transferred to Solicitor's office in 1910.

*Assignment.*—Fred Lees.

*Proposed expenditures, 1918-19.*—\$10,250 (including \$4,250 allotted to the Office of the Secretary—Forest Appeals).

**Operation:**

*Object.*—Administration and supervision of the business organization of the Forest Service and the fire protection and permanent improvement work on the national forests.

*Procedure.*—The Forester, assisted by his staff of inspectors, has general supervision over the organization and business operation of the Forest Service, including both the Washington office and the national-forest districts. This branch is directly responsible for the preparation of estimates and the allotment of funds, the care of quarters, the providing of equipment and supplies, and the furnishing of clerical and other assistance in the Washington office, and has the general direction of these activities in the national-forest districts. It also has general supervision over the personnel, fire protection, and the construction and maintenance of permanent improvements on the national forests. While direct supervision of the forest forces and the details of operation work in general for their respective districts is the business of the district offices of operation, each in charge of an assistant district forester, general control is exercised by the branch through correspondence and reports and personal inspections by the Forester and his assistants.

*Location.*—Washington, D. C.

*Date begun.*—The Branch of Operation was established in 1907.

*Assignment.*—H. S. Graves, D. D. Bronson, Allen S. Peck, A. O. Waha.

*Proposed expenditures, 1918-19.*—\$73,440.

**Silviculture:**

*Object.*—Administration of timber sales, timber surveys, timber and fire trespass, reforestation, administrative use, free use, and insect control; also review and approval of working plans for the better administration of the forests and the conduct of the cooperative projects with Eastern States and timberland owners.

*Procedure.*—The assistant forester in charge of the Branch of Silviculture has general supervision over all activities in connection with the timber business, with the management and use of the forest growth and its protection from depredations by trespassers and by insects and diseases, with the estimates and plans for disposition of timber resources, and with the reforestation of denuded or partially denuded forest areas. Under cooperative agreements he also supervises the preparation and putting into effect of working plans for handling State and private timberlands, for protecting them from fire, etc. Inspectors and expert lumbermen from the Washington office inspect the detail of the work as conducted in the district headquarters offices, in supervisors' offices, and on forest tracts where field operations are being conducted, give advice and assistance where necessary, and standardize, so far as practicable, certain features of the work.

*Cooperation.*—States and timberland owners.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Assignment.*—W. B. Greeley, R. Y. Stuart, E. E. Carter, Clinton G. Smith, Harry Irion.

*Proposed expenditures, 1918-19.*—\$15,927.

**Grazing:**

*Object.*—Administration and general supervision of all matters pertaining to the grazing of live stock upon national-forest ranges and range reserves.

*Procedure.*—The Branch of Grazing, through the district forester in each of the seven districts, directs the work of handling live stock on the national forests. With the approval of the Secretary of Agriculture, it determines the number of stock which shall be grazed upon the forest ranges and establishes the year-long charge for each class of stock. All willful trespass cases for grazing stock on national-forest lands without permit, or for violation of grazing regulations, are passed upon by this branch and forwarded to the Solicitor of the department with proper recommendation. In cooperative work with other bureaus of the department or with other departments in connection with grazing business, all correspondence is handled through the Washington office. Appeals by permittees from the decision of forest supervisors and district foresters are decided by the Forester. Members of the Branch of Grazing make field and office inspections during the year in order to correct errors in the management of grazing business on the forests or in the handling of routine grazing matters at district headquarters or in the supervisors' offices.

*Cooperation.*—Bureaus of Plant Industry, Animal Industry, and Biological Survey, of this department, and Bureau of Fisheries, Department of Commerce.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—Will C. Barnes, J. W. Nelson.

*Proposed expenditures, 1918-19.*—\$10,500.

**Lands:**

*Object.*—General supervision of all matters relating to the application of public-land laws to lands within national forests and the uses of national-forest lands for purposes other than timber sales and grazing.

*Procedure.*—The Branch of Lands gives final supervision to administrative activities incident to the classification of land, the listing of areas for homestead settlement, the survey of agricultural lands, and the handling of individual claims to land under the public-land laws. In addition, it passes on applications for long-term leases of areas in the national forests desired for special personal or commercial purposes and applications for rights of way under various public-land laws. It handles all questions and controversies arising in the various districts growing out of special permits now in effect on the various national forests and all questions of boundary changes proposed by presidential proclamations or special acts of Congress based upon the inclusion or exclusion of public land; also possible changes based upon consolidation of lands through exchanges with States or private owners, in accordance with special acts of Congress. This branch also answers each year thousands of inquiries from prospective homeseekers regarding lands in the national forests and the laws and regulations under which they may be secured and used.

*Cooperation.*—General Land Office, Geological Survey, Reclamation Service, and Office of Indian Affairs, Department of the Interior.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Assignment.*—E. A. Sherman, F. L. Harvey, John D. Jones, W. J. Mangan, Charles H. Squire, R. V. Reynolds.

*Proposed expenditures, 1918-19.*—\$26,740.

**Engineering:**

*Object.*—Administration of water-power uses, of road and trail work, and of engineering work in connection with applications for easements upon the national forests; execution of surveys; and the preparation and maintenance of graphic, photographic, and statistical records.

*Procedure.*—The Branch of Engineering has general supervision over all activities in connection with the issuance of water-power and transmission-line permits under the acts of February 15, 1901, and March 4, 1911, and with examination of and reports upon applications for ease-



ments under the acts of March 3, 1895, March 3, 1891, and February 1, 1905, and of proposed alienations, eliminations, additions, and withdrawals. It has general supervision over the preparation of working plans for road and trail construction under section 8 of the Federal-aid road act and the 10 per cent appropriation and over the negotiations and preparation of cooperative agreements with States and counties for specific road projects and, in cooperation with the Bureau of Public Roads, passes upon plans and specifications for such work. It also has general supervision over all land, boundary, and topographic surveys, except such as are merely incidental to the activities of the Branches of Grazing, Lands, and Silviculture, over all map and other graphic and photographic work, and over the preparation and reproduction of forest folios and general statistical records. The Branch of Engineering establishes standards with respect to instruments and methods for surveying and mapping and cooperates with other branches in the preparation of plans and specifications required in their work.

*Cooperation.*—Bureau of Public Roads, Geological Survey, General Land Office, Coast and Geodetic Survey, Bureau of the Census, States, and counties.

*Location.*—Washington, D. C.

*Date began.*—Engineering was organized as a separate branch on January 1, 1917.

*Assignment.*—O. C. Merrill, T. W. Norcross, L. A. Whitsit.

*Proposed expenditures, 1918-19.*—\$13,970.

### Research:

*Object.*—Administration of silvicultural investigations, including protection studies, the Office of Forest Investigations in Washington, and the silvicultural experiment stations through the district foresters; forest-products investigations, including all investigations of forest-grown products and of wood-using industries; the products offices in the districts through the district foresters, the Madison Laboratory, and the Office of Industrial Investigations in Washington; statistical studies, including the collection of the statistics of wood-using industries; and general economic studies bearing on forestry, forest products, and national-forest management.

*Procedure.*—The research activities are supervised through the chiefs of offices and the district foresters.

*NOTE.*—During 1917-18 much of the regular investigative work of the Branch of Research was curtailed to permit the taking up of projects having a definite bearing on the war.

*Location.*—Washington, D. C.

*Date began.*—Research was organized as a separate branch on June 1, 1915.

*Assignment.*—Earle H. Clapp.

*Proposed expenditures, 1918-19.*—\$22,100.

**Total, General Administration,** \$216,989, including \$118,000 statutory (research, \$22,100; regulation, \$194,889). This total does not include an unallotted contingent of \$23,861.

[Regulation.]

## NATIONAL-FOREST ADMINISTRATION.

### National-Forests Districts:

*Object.*—To administer, protect, develop, improve, and maintain the national forests; to promote the full use of their resources and at the same time prevent waste and preserve the forest cover on the watersheds within the forests.

*Procedure.*—

(1) ORGANIZATION AND PROTECTION: With a view to promote efficiency in protection and prevent delay in the handling of national-forest business, seven field districts, each with a main headquarters office, have been established as follows: District 1, Missoula, Mont. (Montana, northeastern Washington, northern Idaho, and northwestern South Dakota); district 2, Denver, Colo. (Colorado, Wyoming, the remainder of South



Dakota, Nebraska, northern Michigan, and northern Minnesota); district 3, Albuquerque, N. Mex. (most of Arizona and New Mexico); district 4, Ogden, Utah (Utah, southern Idaho, western Wyoming, eastern and central Nevada, and northwestern Arizona); district 5, San Francisco Cal. (California and southwestern Nevada); district 6, Portland, Oreg. (Washington, Oregon, and Alaska); and district 7, Washington, D. C. (Arkansas, Florida, Oklahoma, South Carolina, Georgia, North Carolina, Tennessee, Virginia, West Virginia, New Hampshire, and Porto Rico). Under the same general organization as the main office of the Forest Service at Washington and with the district forester at the head, each of the seven district offices has sections of accounts, law, and engineering and offices of operation, silviculture, lands, and grazing. Each office and section has general supervision over its particular line of activities in the district and on all the national forests of the district. Each national forest is administered by a supervisor with a corps of forest rangers and guards. The supervisors in charge of the 151 national forests, the forest officers in charge of the 10 purchase areas, and the directors of the 6 field experiment stations report direct to the district foresters. The forest force provided by law consists of 150 supervisors, 82 deputy supervisors, 1,030 forest rangers, 100 forest guards for periods not exceeding six months, and 40 forest guards for periods not exceeding three months. Forest assistants and forest examiners are employed in the various subordinate lines of technical and administrative work on the forest under the direction of the supervisor. The national forests are divided into districts, each with a ranger in charge, and during the season of fire danger additional assistants are provided. On each ranger's district a fire-detection system is maintained by patrols and lookouts. The lookouts occupy fixed observation stations on high peaks, and the patrolmen move on horseback, motorcycles, railroad speeders, or along lake shores on launches over certain routes of travel, where risk is concentrated. Guards or firemen with fire-fighting equipment and supplies are stationed at strategic points. All telephones are connected with the main headquarters of the forest. Supervisory officers inspect the work of the men, issue instructions, supply them with equipment, and perfect advance arrangements for quick mobilization and for employing, moving, and equipping fire fighters if a fire gets beyond control of the regular force. About 80 per cent of the time of higher field officers is devoted to protection work during the three to five months fire-danger season. To meet the transportation problem the hire of privately owned conveyances is arranged for in advance. In remote regions trains of Government-owned pack horses are used.

(2) SILVICULTURAL WORK: (a) Timber sales: Commercial timber sales are made in accordance with the act of June 4, 1897; cost sales to homestead settlers and farmers under the act of August 10, 1912. Sales are made by forest officers, the district forester, or the Forester, according to the amount involved. Payment in all cases is made to the district fiscal agent through a designated United States depository. (b) Timber trespass and fire trespass: In all cases of timber or fire trespass a thorough examination is made and report submitted to the proper forest officer. Where legal proceedings are not required, trespass cases may be settled (1) by the district forester up to \$500, (2) by the Forester up to \$5,000, (3) by the Secretary of Agriculture when the amount involved is over \$5,000. Legal proceedings are instituted through the Attorney General. (c) Free use: Timber is granted free of charge for certain uses specified by law, but the cutting and removal is required to be conducted in accordance with departmental regulations. Free-use permits within certain specified amounts are issued by the district forester, supervisor, and forest ranger. Permits in excess of the district forester's authorization must first be approved by the Forester. (d) Insect control: So far as practicable insect infestations are controlled through timber sale, free use, and administrative use. In exceptional cases control projects are inaugurated.

(3) LANDS WORK: (a) Boundary examinations: Forest areas of doubtful or uncertain value for forest purposes, or of possible agricultural value lying near the boundaries of the forests, are inspected by special land examiners. The maps and reports are transmitted by the forest supervisor to the district forester with appropriate recommenda-



tion. The district forester examines them and forwards them to Washington for verification of the status records and submission to the Secretary of Agriculture for final consideration. The proclamation or executive order for elimination is signed by the President. (b) Claims: Upon receipt of notice of a claim for patent or when a claim is being asserted without complying with the requirements of the law, a report of all material facts is prepared and forwarded to the district forester for appropriate action. (c) Administrative sites: Areas needed for administrative purposes, for logging camps, mill sites, banking grounds, nursery sites, etc., are selected, the boundaries marked and location posted, and a record filed in the district office. Areas desired on unappropriated public domain near the forest are withdrawn by presidential proclamation under the act of June 25, 1910. Sites no longer needed are released and revert to their former status. (d) Settlement: The greater part of settlement work under the act of June 11, 1906, is now accomplished through land-classification activities. (e) Special uses and rights of way: Rights of way amounting to easements are secured through the Department of the Interior upon recommendation of the Secretary of Agriculture based on reports of national-forest officers. Permits for ordinary special uses, hotels, summer cottages, and miscellaneous commercial purposes are granted by forest supervisors upon application made through the forest rangers. In cases requiring the signature of the district forester or Forester the forest supervisor submits a report on which the action is based. (f) Occupancy trespass: The facts relating to an unpermitted occupancy of national-forest lands are obtained by the forest supervisor and submitted by him to the district forester. The latter, if unable to adjust the matter, forwards the report to the assistant to the Solicitor, who, if the facts warrant, recommends that the Department of Justice be asked to institute appropriate proceedings to protect the interests of the United States. Cases of this character have almost entirely disappeared.

(4) GRAZING BUSINESS: A constant effort is made to so manage the grazing business on the national forests as (1) to guarantee continued production both of the range and of young forest growth, (2) to utilize all the range to its full capacity, (3) to secure its use to settlers and others most entitled, (4) to improve the range and the quantity and quality of the stock produced, and (5) to secure a fair return to the public—the owners of the range. To insure proper supervision and control of the range, permits are required for all stock grazed on the forests. The district foresters fix the short-term fees for the forests in their respective districts, basing the charges on the year-long rates determined by the Forester. Free permits are granted to settlers for small numbers of stock. Forest rangers are required to see that applications for permits are filed properly and at the right time. They inspect and count the stock taken into the forest. During the season, they go over the range to see that the stock are properly distributed and according to the capacity of the range and that they are adequately salted. They adjust minor differences between stockmen, locate pasture or drift fences, investigate outbreaks of stock diseases, locate and guard against poisonous-plant areas, assist in exterminating predatory animals, and look after the crossing of transient stock. Experts make studies of the carrying capacity of the range, the restoration of worn-out ranges, the handling of stock, and the effect of grazing upon forest reproduction and growth and upon erosion and watersheds.

(5) ENGINEERING WORK: (a) Execution of land, boundary, and topographic surveys, except such as are merely incidental to the activities of the Branches of Lands, Grazing, or Silviculture, and compilation and preparation of national forest maps for printing; (b) administrative reports upon and preparation of working plans by States for road and trail construction under the 10 per cent appropriation and under section 8 of the Federal-aid road act, and negotiations for and preparation of cooperative agreements for such work with States, counties, and other agencies; (c) field examinations and reports upon applications for rights of way for water-power development and for transmission lines, determination of conditions under which national-forest lands may be occupied and used for such purposes, and the preparation of reports and drafts of agreements for submission to the Secretary of Agriculture for



approval; and (d) examination of and reports upon applications for easements over national-forest lands and upon proposed alienations, eliminations, additions, and withdrawals.

*Cooperation.*—Forest users, railroad and telephone companies, owners of timberland, and State organizations.

*Location.*—District and national-forest headquarters and national forests.

*Date begun.*—Administration of the national forests was provided for by act of Congress in 1897. The first express appropriation for the protection of the public timberlands was passed in 1872.

*Results.*—

(1) ORGANIZATION AND PROTECTION: During the first 10 months of the fiscal year 1918 the revenues from forest resources were 10 per cent greater than for the same period of the previous year and over 300 per cent greater than for the entire fiscal year 1906, the first full year after the forests were placed under the control of the Department of Agriculture. The expenditures for forest administration and protection, on the other hand, have shown no material increase for the past seven years, except for those years when there were unusual expenditures on account of fire suppression. The establishment of the national forests was not primarily to secure revenue but rather to accomplish certain large public benefits. The greater part of the work, therefore, is not designed to produce revenue, immediately at least, but is devoted to the organization, building up, and protection of the forests and the development and utilization of their resources. As handled, the utilization of the forest resources involves no sacrifice of public interests but rather is in furtherance of them. The policy is to extend the utilization of the resources in such a way as to meet the purposes of the establishment of the national forests and at the same time to place them ultimately on a complete self-supporting basis. During 1916 the revenues from forest resources in five States more than paid the ordinary operating expenses in those States, and eight other States were not far behind. As the resources are constantly renewed through application of the principles of forestry, the annual revenue received is derived solely from the utilization of the natural increment of production and is not in any way at the expense of the capital invested. Protection of the forests from fire is fundamental, and over 40 per cent of the Forest Service funds are devoted to this purpose. From 2,000 to 7,000 fires are contended with each year, with an average of about 5,000. Ordinarily, with the present organization, about 95 per cent of the fires are extinguished with less than \$100 damage, and about 75 per cent are confined to less than 10 acres.

(2) SILVICULTURAL WORK: (a) Timber sales: In 1917 contracts were entered into for the sale of 2,005,379,000 feet of national-forest timber, valued at \$3,703,626.02. A total of 726,760,000 feet of timber, valued at \$1,505,435.84, was cut under sales during the year. (b) Timber and fire trespass: Timber trespass on the national forests continues to diminish in extent. At the end of the fiscal year 1917 there were 42 pending cases, as against 53 at the close of 1916. There were also 28 fire-trespass cases pending, as against 19 pending at the close of 1916. (c) Free use: During the fiscal year 1917, 28,064 free-use permits were issued and, in addition, 13,188 users secured free timber on free-use areas without written permits. (d) Insect control: The more important insect-control operations conducted during the fiscal year 1917 were on the Lassen and Sierra National Forests in California.

(3) LANDS WORK: (a) Boundary examination: The present national-forest boundaries may be considered as essentially permanent, in a general sense. The lines have been drawn so as to include, so far as practicable, only such lands as are valuable for timber or watershed-protection purposes. However, minor modifications are found necessary as a result of the land-classification work, by which the lands within the forests are being examined in detail and permanently classified. As this work progresses and the classification of individual forests is completed, final adjustments in their boundaries are made, and the boundary work is thus very closely related to land classification. During the past year a number of proclamations and executive orders have been issued making eliminations and boundary changes of this character. (b) Claims: During 1917, 1,701 bona fide claims were acted upon favorably for the claimants, and



111 fraudulent cases were acted on adversely. (c) Settlement: Since the passage of the forest homestead act of June 11, 1906, up to June 30, 1917, there have been listed for entry 19,503 individual tracts, with an area of over 2,123,280 acres. (d) Special uses and rights of way: At the close of the fiscal year 1917 there were 21,579 permits in effect authorizing the occupancy of small areas for miscellaneous uses; 11,733 of these were free, and 9,846 paid fees amounting to \$107,535.85.

(4) GRAZING BUSINESS: During the first 10 months of the fiscal year 1918 the receipts from grazing fees were nearly 25 per cent greater than during the same period for the previous year. The receipts from grazing fees in 1917 were \$1,549,794.76, involving 36,639 permits and covering nearly 2,054,350 head of cattle, horses, and swine, and 7,635,973 sheep and goats. In addition, free crossing permits and free grazing permits on account of private land were issued for 132,340 head of cattle and over 3,885,983 sheep and goats. Careful management and the adoption of improved methods developed by scientific study and experiment have increased the carrying capacity of the range and have made range conditions in general 25 to 100 per cent better than when the national forests were created. Ranges are now equitably apportioned and each permittee protected in the use of his allotted range, overgrazing and improper use prevented, erosion lessened, forage productivity of denuded areas increased, friction between stockmen eliminated, the spread of stock diseases checked, the ravages of predatory animals reduced, poisonous-plant areas guarded against, quarantine regulations enforced, previously unused ranges utilized, forage resources developed and improved, and new and better methods of handling stock introduced.

(5) ENGINEERING WORK: (a) The original administrative atlas is being revised and new forest maps prepared as fast as funds are available and data can be secured. About 35 per cent of this work had been completed at the close of the fiscal year 1918. (b) During the fiscal year 1918, 135 miles of road were constructed from 10 per cent funds. (c) Receipts for water power for the fiscal year 1918 were \$93,976.35. On July 1, 1918, 196 permits were in effect for water-power projects and 155 additional permits covering transmission lines only. The estimated capacity at minimum stream flow of the sites under permit was 776,709 horsepower. Of this amount 405,368 horsepower was completed and 157,502 horsepower in process of construction, and for 213,839 horsepower construction has not started. During the year permits were issued for 28 power projects and 31 transmission lines.

*Assignment.*—R. H. Rutledge, Missoula, Mont.; Smith Riley, Denver, Colo.; Paul G. Redington, Albuquerque, N. Mex.; L. F. Kneipp, Ogden, Utah; R. Headley, San Francisco, Cal.; George H. Cecil, Portland, Oreg.; William L. Hall, Washington, D. C.

*Proposed expenditures, 1918-19.*—\$3,822,177, including \$2,141,900 statutory.

#### [Regulation.]

### LAND CLASSIFICATION AND EXCHANGE.

#### Land Classification and Exchange:

*Object.*—The classification and segregation of lands within the national forests that may be opened to settlement and entry under the homestead laws applicable to the national forests or that should properly be eliminated therefrom; the designation and segregation of all lands required permanently for national-forest purposes: also the examination and appraisal of lands in consummating exchanges authorized by law.

*Procedure.*—Thorough field examination forms the basis of the work. This includes the gathering of information relative to the topography, climate, accessibility of the land, and character of the soil: amount, character, and value of the standing timber: value of the land for watershed protection, and the use which is being made of other similar land in the vicinity. Detailed maps are prepared, illustrative especially of the timber and soil conditions, and these maps, accompanied by typewritten reports, are submitted by the local forest supervisor to the district forester for review. After approval by the district forester the reports and maps are acted upon by the forester and then submitted to the Secretary



of Agriculture for final action. Approval by the Secretary results in the official classification of the land involved or in final action in land exchanges.

*Cooperation.*—Bureau of Soils.

*Location.*—Washington, D. C., district and national-forest headquarters, and national forests.

*Date begun.*—1912.

*Results.*—To date 142,012,826 acres have been finally reported upon and classified. Lands found to be "chiefly valuable for agriculture" either have been listed and made available for entry under the forest homestead act of June 11, 1906, or have been eliminated from the national forests and restored to the public domain.

*Assignment.*—E. A. Sherman, John D. Jones, district foresters, and forest supervisors.

*Proposed expenditures, 1918-19.*—\$79,845, including \$4,800 statutory and \$4,945 unexpended balance of appropriation for land exchange in the State of Washington.

[Regulation.]

## ENTRY SURVEYS.

### Entry Surveys:

*Object.*—The final survey for patent of homesteads on national forests initiated under the forest homestead act of June 11, 1906, and the act of March 3, 1899.

*Procedure.*—Upon request by the district forester the United States Surveyor General issues to the Forest Service surveyor detailed special instructions for the entry survey of each tract listed or to be listed to an individual. After the survey is executed in the field the necessary plat and field notes are prepared and submitted to the Surveyor General. When approved by him these returns are transmitted to the General Land Office in Washington. If found correct, the survey is accepted by the Commissioner of the General Land Office, and photographic copies of the plat (made by the Forest Service) are supplied to the homestead entryman and to the local land office for use in the submission of final proof upon the entry.

*Cooperation.*—General Land Office and United States Surveyor General.

*Location.*—Washington, D. C., district and national-forest headquarters, and national forests.

*Date begun.*—1913.

*Results.*—In the five years since this work was undertaken approximately 3,300 homestead claims have been surveyed in the field. Two thousand five hundred of these surveys have been approved by the several United States surveyors general and 2,147 of these accepted by the General Land Office. Of the remaining cases, 73 have been abandoned on account of the General Land Office survey becoming available, thereby reducing the expense. The remainder are either in course of preparation or pending before the surveyors general or the General Land Office.

*Assignment.*—R. V. Reynolds, district foresters, and forest supervisors.

*Proposed expenditures, 1918-19.*—\$74,880, including \$25,180 statutory.

[Regulation.]

## FIRE SUPPRESSION.

### Fire Suppression:

*Object.*—Suppression of fires on the national forests.

*Procedure.*—A regular system of fire protection is maintained on each national forest, the objects being (1) prevention and (2) suppression. When forest fires can not be handled by the regular force, temporary fire fighters are employed and paid from the special fund for fire suppression. Fire-fighting supplies, freight, hauling, and other expenses incident to fire suppression are also paid from this fund.

*Cooperation.*—Forest users, settlers, railroad companies, owners of timberland, and State organizations cooperate in both fire suppression and fire prevention.



*Location.*—National forests.

*Date begun.*—The first specific appropriation for fire fighting was made in 1911.

*Results.*—During the calendar year 1917, 7,814 fires on the national forests, causing an estimated damage of more than a million dollars, were extinguished. This work involved an expenditure of \$1,046,938, in addition to the salaries of the regularly employed officers who took part in the fire fighting, which amounted to \$74,518.

*Assignment.*—Forest supervisors, rangers, and guards.

*Proposed expenditures, 1918-19.*—\$150,000.

[Regulation.]

## MAINTENANCE AND SUPPLIES.

### Supply Depots:

*Object.*—To purchase, care for, and distribute necessary instruments, equipment, and supplies for the use of supervisors and other forest officers in all branches of the Forest Service.

*Procedure.*—The property clerks purchase all necessary supplies, instruments, and equipment, maintain a stock of standard supplies and equipment, and issue them to the various forest officers upon requisition.

*Location.*—Ogden, Utah, and Washington, D. C.

*Date begun.*—The depot at Ogden was established in 1907.

*Results.*—By the establishment and maintenance of supply depots the Forest Service has been able to secure reduced prices by wholesale purchase. In field work it has been possible to avoid the delay which would necessarily result from the purchase and shipment of supplies in small quantities to a widely scattered field force. Purchases also have been standardized and a higher grade of equipment secured and at less cost.

*Assignment.*—A. H. Cousins, Ogden, Utah; S. L. McLaurin, Washington, D. C.

*Proposed expenditures, 1918-19.*—\$182,740.

### Property Auditor:

*Object.*—To keep a record of all the property of the United States in the custody of the Forest Service.

*Procedure.*—The property auditor keeps a complete record of the value, location, condition, and disposal of all instruments, equipment, supplies, and permanent improvements purchased or constructed by and owned by the Forest Service.

*Location.*—Ogden, Utah.

*Date begun.*—1907.

*Results.*—The property auditor's record enables the Forester to know at any time the location, value, and to a certain extent the condition of all property owned by the Forest Service. As each forest officer is held personally responsible for property issued to him, loss and waste are reduced to the minimum.

*Assignment.*—J. G. Falck.

*Proposed expenditures, 1918-19.*—\$10,580.

**Total, Maintenance and Supplies, \$193,320, including \$32,220 statutory.**

[Research.]

## FOREST-PRODUCTS INVESTIGATIONS.

### National-Forest Utilization:

*Object.*—To assist and advise the district foresters on national-forest market and utilization problems; to make investigations bearing upon administrative problems, in cooperation with the Forests-Products Laboratory and the Office of Industrial Investigations.

*Procedure.*—Advice is furnished to district foresters upon request. Studies and investigations are made in cooperation with the other investigative units of the service, subject to the immediate control of the district foresters, under many of the projects which follow.

*Cooperation.*—Various industrial organizations.

*Location.*—Washington, D. C., Missoula, Mont., Portland, Oreg., and San Francisco, Cal.



*Date begun.*—1909.

*Results.*—These are largely in the nature of current advice and assistance to the district foresters in the administration of timber sales and in the dissemination of useful information and assistance to local timber owners, manufacturers, wood-using industries, and the general public. Results in intensive investigations are indicated under the projects which follow.

*Assignment.*—Cary L. Hill, C. N. Whitney.

*Proposed expenditures, 1918-19.*—\$5,200.

### **Industrial and Statistical Investigations:**

*Object.*—To conduct statistical studies of the production and consumption of lumber and other forest products and of prices for stumpage and market products; to make studies of processes, costs, etc., in various wood-using industries, and of wood utilization and waste; and to co-operate with other Federal departments in the purchase and handling of lumber.

*Procedure.*—Statistics are collected annually except when undertaken by the Bureau of the Census. Field studies are made of the wood-using industries; the wood-waste exchange being continued very largely through correspondence. Cooperation with other Federal departments in the purchase and handling of lumber is maintained and developed as opportunity offers. Inspection of navy yards, lumber shipments, etc., is undertaken when requested.

*Cooperation.*—Bureau of the Census, Bureau of Crop Estimates, Panama Canal Commission, Navy Department, War Department, Office of Indian Affairs, War Trade Board, War Industries Board, lumber manufacturers' associations and other trade organizations, and various State forestry officials.

*Location.*—Washington, D. C., and district offices.

*Date begun.*—1905.

*Results.*—(1) Prior to 1918: Annual statistics on lumber have been obtained since 1905 and figures on other forest products until 1911. Data obtained show the consumption of lumber by the wood-manufacturing industries by States, industries, and species. Lumber prices form part of a continuous record maintained since 1908. Those secured in cooperation with the national-forest districts are essential in the appraisal of stumpage. Compilation of stumpage values is of economic importance in showing the general trend of timber values. Cooperation with the Forest-Products Laboratory at Madison aided in the formulation of a scientific grading rule for yellow-pine structural timber. A utilization study of blight-killed chestnut, in cooperation with the Bureau of Plant Industry and with States, demonstrated the merchantability of sound, dead chestnut and the most profitable methods of utilization, located markets, and resulted in salvaging considerable dead chestnut. Thirty-four State wood-using industries reports have been published in cooperation with State officials. Hickory-handle specifications prepared by the Forest Service have been adopted by the Panama Canal Commission and the Navy and War Departments. Cooperation with Government departments included the inspection of lumber and the revision of specifications.

(2) During the fiscal year 1918 cooperation continued with other departments, consisting mainly of the inspection of navy yards, preparation of lists of possible bidders, furnishing price data, and in acting as a clearing house for the revision of specifications, advice on the suitability of various woods for specified uses, and advice on methods of hauling and storing lumber. Statistics were collected on lumber production, the quantity of wood preservatives used and the amount of wood treated, and pulp-wood consumption and wood-pulp production. Reports on "Lumber Used in the Manufacture of Wooden Products" and "Seasoning of Wood" were published as Department Bulletins 552 and 605. Records of lumber prices secured in cooperation with district offices, lumber associations, and mills were issued quarterly. The wood-waste exchange, instituted to enable manufacturers with waste to get in touch with manufacturers needing small pieces as raw materials, resulted in the utilization of considerable waste in the manufacture of small wooden articles. The greater part of the work of the office was devoted to cooperation with



various Government agencies in the prosecution of investigations relating directly to the war.

*Assignment.*—H. S. Betts, Rolf Thelen, Harry P. Burden.

*Proposed expenditures, 1918-19.*—\$37,430.

### **Forest-Products Laboratory Supervision:**

*Object.*—Administration and supervision of experimental investigations into the use, handling, and preservation of forest-grown products, conducted by the Forest-Products Laboratory; includes maintenance of laboratory and library.

*Procedure.*—The activities of the laboratory are supervised through the chiefs of sections in charge of the various lines of work.

*Cooperation.*—Bureau of Plant Industry, University of Wisconsin, University of Washington, and various engineering, chemical, and lumber associations, societies, and companies.

*Location.*—Madison, Wis., with branch at Seattle, Wash.

*Date begun.*—1902. (Laboratory at Madison in 1910.)

*Assignment.*—C. P. Winslow, O. M. Butler.

*Proposed expenditures, 1918-19.*—\$40,330.

### **Timber Physics:**

*Object.*—To secure information (1) on structure which will permit the classification or identification of woods, (2) on the relation of structure to the fundamental physical or mechanical properties, (3) on the relation of structure to drying and uses, and (4) on the fundamental physical properties, including changes under changing conditions in their relation to drying and all practical uses.

*Procedure.*—The work involves exhaustive studies of the structure of woods by the use of the microscope and photomicrographs, of the physical properties of wood, and of the effect on properties of conditioning or treating under high pressures, temperatures, etc.; also intensive experiments with semicommercial apparatus on methods of kiln-drying and practical demonstrations in commercial plants of promising results.

*Cooperation.*—University of Wisconsin, various lumber manufacturers, etc.

*Location.*—Madison, Wis.

*Date begun.*—1903.

*Results.*—(1) Prior to 1918: A type of dry kiln has been designed and processes developed which show much greater efficiency than in average industrial practice. About 50 commercial concerns have installed dry kilns along the lines of these developments. Kiln-drying experiments have been conducted on a large number of different woods. Over 1,100 samples of wood are annually identified and the information furnished to the public. The relation of moisture to the mechanical properties of wood was developed.

(2) During 1918 additional data were secured on fundamental physical properties. Experiments in kiln drying were carried on and successful methods of drying thin woods in a period of two weeks were developed with spruce, walnut, oak, Douglas fir, hickory, and birch. An unnumbered publication entitled "Guide Book for the Identification of Woods Used for Ties and Timbers" was issued.

*Assignment.*—O. M. Butler, E. Gerry.

*Proposed expenditures, 1918-19.*—\$28,700.

### **Timber Tests:**

*Object.*—To secure reliable data on the mechanical properties of various species and forms of timber for the use of engineers, manufacturers, and other users of wood, and of foresters, making possible the development of grading rules and specifications on a scientific basis and permitting the most advantageous use of various species and forms.

*Procedure.*—The work involves exhaustive tests of small clear specimens of woods of different species and similar tests of timbers of structural sizes, both of which are preliminary to the development of grading rules; and to some extent tests with special forms of material, such as packing boxes, barrels, shipping containers, etc.

*Cooperation.*—University of Wisconsin and University of Washington.

*Location.*—Madison, Wis., and Seattle, Wash.

*Date begun.*—St. Louis, 1890; Madison, 1909.



*Results.*—(1) Prior to 1918: Approximately 129,000 tests were completed on over 100 American species. Grading rules formulated by the American Railway Engineering Association and also those of the American Society for Testing Materials have been largely based on Forest Service tests. Tests on hickory have resulted in a modification of specifications by the National Association of Hickory Manufacturers and by the Navy Department to permit the use of both red and white hickory. Tests of tapped and untapped southern pine have shown that tapping has no effect on strength. Tests on California tanbark oak have shown it to be suitable for many purposes for which eastern oak is used. Tests with shortleaf pine and white-cedar cross arms have shown these species to compare favorably with Douglas fir and longleaf pine. Steaming timber before preservative treatment has been shown frequently to reduce strength, and this method has been very largely discontinued or modified. Investigations to improve the design and methods of construction of containers were inaugurated to reduce the present annual loss to railroads of approximately \$40,000,000 for goods lost or damaged in transit.

(2) During the fiscal year 1918 the scope of a study of specifications and designs for packing boxes and shipping containers was greatly enlarged and continued. Further tests were made to compare the efficiency of different types of wooden containers for overseas shipment. Approximately 50,000 tests were made on small specimens to secure information on the mechanical properties of various species. Additional tests were made to determine the efficiency of various types of wooden joints.

*Assignment.*—J. A. Newlin, T. R. C. Wilson, A. Elmendorf, D. L. Quinn, E. R. Maurer, and L. J. Markwardt, at Madison, Wis.; C. W. Zimmerman, at Seattle, Wash.

*Proposed expenditures, 1918-19.*—\$36,320.

### Wood Preservation:

*Object.*—To secure data which will serve to promote the protection and preservation of wood from destruction by decay, fire, abrasion, or marine borers.

*Procedure.*—The work involves the determination of the physical and chemical properties of preservatives and fire retardants; intensive studies of the processes and relative ease with which preservatives may be injected into different species; studies to determine the relative resistance of treated and untreated woods to decay and the relative toxicity of various preservatives; intensive studies to develop cheap and highly toxic preservatives and cheap and effective fire retardants; laboratory tests to determine the comparative efficiency of fire retardants; technical investigations with semicommercial apparatus of the most efficient methods of treating with various preservatives woods of different kinds and forms; and tests with timbers, ties, poles, paving blocks, mining timbers, piling, etc., to determine under actual service conditions the life of various species differently treated for various uses in different regions.

*Cooperation.*—University of Wisconsin.

*Location.*—Madison, Wis.

*Date begun.*—1903.

*Results.*—(1) Prior to 1918: Tests on over 30 commercial wood preservatives were completed, including an intensive study of the physical and chemical properties of various types of creosotes. Comparative studies on the relative ease of treatment of conifers were completed and similar studies on hardwoods undertaken. Many data were secured on the effect of variables in treatments on the efficacy of the process. During 1914 special attention was devoted to methods of rendering wood fire retardant. Tests to compare the life of treated and untreated material under actual service conditions were inaugurated in cooperation with railroad companies, municipalities, telephone companies, mine companies, etc. Forty-two sets of test material in various parts of the country have been inspected at regular intervals. It has been shown from these experiments that the life of wood in exposed situations may in general be increased at least three times by proper preservative treatment and that many woods of comparatively little natural value for railroad ties, such as loblolly pine, jack pine, lodgepole pine, etc., can be treated readily and



made suitable. The use of such material for ties has doubled within the last five years. Results of studies of paving-block treatment have been largely utilized by Chicago and other municipalities in specifications. Intensive studies have been conducted on the methods of analysis, etc., of wood preservatives. The specifications of the American Railway Engineering Association and the National Electric Light Association are largely based on this work. Methods of treating poles and posts by the brush and open-tank processes have been investigated, and the specifications adopted by the National Electric Light Association are based on the results. Studies of methods of treating Douglas fir without causing loss of strength have been conducted and methods developed which indicate a great improvement over former practice.

(2) During 1918: A series of tests was conducted on the efficiency of various water-resistant coatings, including paints, oils, etc. An investigation of the properties of various glues was made and several new glues developed. Department Bulletin 606, "Relative Resistance of Various Hardwoods to Injection with Creosote," was published.

*Assignment.*—C. H. Teesdale, G. M. Hunt.

*Proposed expenditures, 1918-19.*—\$20,520.

### Wood Distillation and Derived Products:

*Object.*—To secure data on the chemical composition and chemical properties of wood; on the suitability of different woods and wood waste, and other forest-grown material for derived products, including those of wood distillation, the naval-stores industry, grain alcohol from sawdust, producer gas from wood waste, etc.; and on the most efficient methods of producing and refining these derived products and their chemical composites and uses.

*Procedure.*—Methods are being developed for the chemical analyses of woods in wood distillation, production of ethyl alcohol, etc. Technological studies are conducted on a semicommercial basis to determine the effect of the fundamental variables on the efficiency of the process and to determine the suitability of different forms and species of woods. In the naval-stores work, in addition to distillation studies, field investigations of extraction and yields from different species under varying methods are conducted, the products are chemically analyzed, refining processes studied, efforts made to develop uses, and the promising results demonstrated commercially.

*Cooperation.*—University of Wisconsin and various engineering, chemical, and lumber associations, societies, and companies.

*Location.*—Madison, Wis.

*Date begun.*—1907.

*Results.*—(1) Prior to 1918: In the destructive distillation of hardwoods an improved method greatly increased the yield of alcohol and acetate of lime. These methods were partially demonstrated on a commercial scale. Tests have shown that commercial yields of acetate of lime and wood alcohol can be obtained from hickory, oak, tupelo, and red gum. The results of investigations with wood turpentine have been used in formulating specifications adopted by the American Chemical Society, the American Society for Testing Materials, the Navy Department, and the Isthmian Canal Commission. Progress was made in determining the effect of some of the fundamental variables involved in the production of ethyl alcohol from wood waste. Tests were completed on the quantity and character of oils which may be secured from leaves and twigs of conifers, and these oils are under commercial test to determine their usefulness. Field experiments comparing improved methods of cupping with the boxing in common industrial use showed marked improvement for the new method in yield of gum and in reducing deterioration of lumber. These improved methods of turpentering have been largely adopted in the trade. Experiments in Arizona, California, and Colorado showed yields of turpentine and rosin from western yellow pine sufficiently great to make this species a possible future source of naval stores. Tests to determine the suitability of a number of species for the production of ethyl alcohol have been conducted. Studies to determine the value of osage orange as a dyewood have resulted in the commercial utilization of a considerable quantity of material formerly wasted.



(2) During 1918: Further work on methods for increasing the yield of valuable products, particularly acetate of lime, in the commercial distillation of woods was carried on. Preliminary experiments indicate that the yield of acetate from the destructive distillation of wood can be increased several times by the use of certain mineral acids. An investigation has been carried out on the method of manufacturing potash from wood ashes. Costs of operation have been obtained and an estimate made on the amount of wood ashes available for this purpose. Department Bulletin 567, "Increased Yield of Turpentine and Rosin from Double Chipping," was published.

*Assignment.*—E. Bateman, L. F. Hawley.

*Proposed expenditures, 1918-19.*—\$23,720.

### **Pulp and Paper Investigations:**

*Object.*—To secure information on the suitability of different woods for pulp under various methods of manufacture; to increase the efficiency of the various established industrial processes and develop new and improved processes.

*Procedure.*—The work involves technological experiments with semicommercial apparatus, together with detailed chemical analyses and microscopic studies of wood structure, pulp fibers, etc. Promising results are demonstrated on a commercial scale.

*Cooperation.*—University of Wisconsin.

*Location.*—Madison, Wis.

*Date begun.*—1905.

*Results.*—(1) Prior to 1918: Tests showed that pulps suitable for commercial use as news and wrapping paper can be made by the sulphite process from eight species of native woods, several of which grow in large quantities on the national forests, some of them being now used to a limited extent and others not at all. Other species are under investigation. Tests have shown that three native species—jack pine, tamarack, and hemlock—of which large quantities are available in the Lake States, can be satisfactorily substituted for spruce in the ground-wood process in making the cheaper grades of paper, such as news and wrapping. Several mills have begun grinding these woods. A number of western woods were also tested. Tests have shown that pulps suitable for book or wrapping paper can be made from 12 new species of native woods by the soda process. Several other native species show commercial possibilities as soda pulp woods. Tests showed that the highest grades of "kraft" paper can be made from long-leaf pine by the soda and sulphate processes. A number of methods of increasing the yield of pulp from the raw material without decreasing the quality of the product have been found. Tests by the sulphate process, now little used in the United States, have shown especial possibilities as a means of making paper from mill waste. A method was devised for the recovery of turpentine and rosin from woods while cooking by the sulphate process.

(2) During 1918: Comparative pulp-making tests with various forest woods were continued. Bleach tests were made on sugar pine, black willow, Engelmann spruce, Sitka spruce, balsam fir, white pine, yellow birch, grand fir, white spruce, western hemlock, tamarack, red oak, red fir, ash, and others. A study was made of fiber-composition plugs as compared to ordinary wooden plugs. It was found that the fiber plug is considerably stronger than the wooden plug. Many commercial demonstrations were made in the field. Department Bulletin 620, "Effect of Varying Certain Cooking Conditions in the Production of Sulphite Pulp from Spruce," was published.

*Assignment.*—O. Kress, S. D. Wells, H. E. Surface.

*Proposed expenditures, 1918-19.*—\$19,460.

### **Lumber Industry Studies:**

*Object.*—To secure authoritative information on the underlying causes of the present unsatisfactory conditions in the lumber industry, so that the Government may be in a position to deal constructively and helpfully with the situation, both from the standpoint of the public and the industry; to secure valuable data on methods and costs of logging and lumber manufacture and the equipment employed, as a basis for stumpage appraisals and the development of proper relations between lumber-



ing and forestry; to secure special information by mill-scale and depreciation studies in regard to yield and quality of lumber from different grades, sizes, and species of logs in different sections of the country, also the depreciation in value of lumber from the time it is cut until shipped, particularly for use in connection with appraisals of Forest Service stumpage; to secure information on waste in connection with logging and milling operations.

*Procedure.*—Special investigators confer with leading men in the industry and visit carefully selected producing operations or distributing concerns, making field studies of operations or critical reviews and analyses of records, or both. The economic phase of this study will be extended to regions not yet covered. In the case of mill-scale and lumber-depreciation studies detailed grading and other records of the logs and mill products are made. A number of additional studies of this character will be made for new species and regions. Exact data on waste will be secured for various species in the woods and at the mill.

*Cooperation.*—Federal Trade Commission, in the economic study; various associations and lumber companies, in methods and costs and mill-scale, depreciation, and waste studies.

*Location.*—Washington, D. C., Madison, Wis., district offices, and national forests; also particular lumber-producing and distributing regions outside of national-forest regions.

*Date begun.*—Mill-scale and depreciation studies, 1903; costs and methods studies, 1912; economic study, 1914.

*Results.*—(1) Prior to 1918: A large amount of data has been collected in the economic study and also for many regions of the United States on lumbering methods and costs and in mill-scale, depreciation, and waste studies. A summary of the study, compiled largely from data obtained by the authors of the more detailed reports dealing with particular phases of the lumber industry, was published. A report on "Timber Ownership and Lumber Production in the Inland Empire" was completed.

(2) During 1918: A report on "Timber Ownership and Lumber Production in the Southern Pine Region" and a similar report covering California conditions were completed and further progress made on a report for the Douglas-fir region. Office of the Secretary Reports 115, 116, and 117, "The Distribution of Softwood Lumber in the Middle West—Wholesale," "The Distribution of Softwood Lumber in the Middle West—Retail," and "The Substitution of Other Materials for Wood," were published. Field work on this general project was continued.

*Assignment.*—H. S. Graves, Earle H. Clapp, C. P. Winslow, H. S. Betts, C. S. Smith, O. M. Butler, Rolf Thelen, R. C. Bryant, F. E. Olmsted.

*Proposed expenditures, 1918-19.*—\$15,620.

**Total, Forest-Products Investigations, \$227,300, including \$55,180 statutory.**  
This total does not include an unallotted contingent of \$1,140.

#### [Research.]

### RANGE INVESTIGATIONS.

#### Supervision, Inspection, and General Investigations:

*Object.*—Office supervision, field inspection and supervision of all work connected with range investigations carried on by the Forest Service, and collection of data of a general character during the course of field inspection.

*Cooperation.*—Office of Economic and Systematic Botany, Bureau of Plant Industry.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Assignment.*—J. T. Jardine.

*Proposed expenditures, 1918-19.*—\$5,220.

#### Artificial Reseeding:

*Object.*—To determine (1) the lands where seeding to cultivated species of forage plants is economically possible from the range standpoint; (2) the species best adapted to any given set of conditions; (3) the best time to sow and the cultural methods which should be adopted; (4)



the necessary protection against grazing; and (5) the possibility of growing promising native species under cultivation and securing seed of such species for use in range reseeding.

*Procedure.*—Major investigations are conducted on small areas in a few localities by investigators especially qualified. These intensive studies have been supplemented by over 500 seeding tests carried out by members of local forest forces. The work during the coming year will be confined to thorough small-scale investigations at experiment stations where men specially qualified for these investigations are located and to a few national forests where additional experimental tests seem to be warranted.

*Cooperation.*—Office of Economic and Systematic Botany, Bureau of Plant Industry.

*Location.*—Manti National Forest, Utah; Coconino National Forest, Ariz.; Jornada Range Reserve, N. Mex.; Crater National Forest, Oreg.; and Okanogan National Forest, Wash.

*Date begun.*—1907.

*Results.*—(1) Investigations prior to 1918 indicated that (a) seeding range lands to cultivated species is economically possible only on mountain meadows and other areas of minor extent having favorable soil and moisture conditions and under 500 feet below the true timber line; (b) late fall seeding and planting the seed by harrowing or trampling with sheep or by other means are advisable; (c) protection against grazing is essential the first year after seeding. The results on which these and other conclusions were based were published in Department Bulletin 4. The results of investigations since 1912 indicate that it will be difficult and, if finally feasible, will require considerable time to place promising native forage plants under cultivation in order to secure seed at a cost not prohibitive to distribution in reseeding depleted ranges where the present cultivated species will not make a successful growth.

(2) During 1918: Results secured during 1918 confirmed the major conclusions of previous work and furnished further data of value in selecting areas where seeding may be advisable and in selecting species. Additional data on time of seeding show that seeding in early summer produces the best results on land between 8,000 and 10,000 feet altitude in central Utah. Results from seeding tests on the Okanogan National Forest indicate a possibility of successful seeding on certain forests of the Northwest on a larger scale than has hitherto been considered advisable. Further tests are needed, however, before definite conclusion is reached and large expenditures recommended. Results from collecting seed of a few promising native species and seeding it on denuded lands in the locality where the seed was collected indicate a possibility of hastening revegetation in this way without unwarranted expense. Tests on a larger scale will be undertaken during 1919.

*Assignment.*—A. W. Sampson, G. A. Pearson, C. L. Forsling, J. L. Peterson.  
*Proposed expenditures, 1918-19.*—\$2,000.

### Natural Reseeding:

*Object.*—To develop plans of range management which will secure natural reseeding of range lands with a minimum loss of forage through nonuse.

*Procedure.*—In studying this problem the first step is to determine for the principal range plants making up the forage crop the time growth begins and ends, the time of flowering, time of seed maturity, amount of seed produced, germination of seed, and other facts influencing the power of the plants to reproduce themselves naturally under range conditions. With these data available a comparative study is made of reproduction under total protection from grazing, grazing after seed maturity, and the existing grazing practice, with a view to work out a system of grazing which will allow the use of all forage each year and at the same time keep the forage plants vigorous and occasionally allow the production of a seed crop.

*Cooperation.*—Office of Economic and Systematic Botany, Bureau of Plant Industry.

*Location.*—Great Basin Experiment Station on the Manti National Forest, Utah; Medicine Bow National Forest, Wyo; Jornada Grazing Reserve, N. Mex.; and Santa Rita Grazing Reserve, Ariz.

*Date begun.*—1907.



*Results.*—(1) Prior to 1918: As a result of the studies in natural reseeding, the system of "deferred and rotation" grazing now being put into application on national-forest ranges has been worked out. The principles upon which this system is based are fundamental, and it remains to adapt them to local conditions. Results were published in Department Bulletin 34 and in the Journal of Agricultural Research, vol. 2, No. 2. Short articles have been published in outside journals.

(2) During 1918: Observations during 1918 confirmed conclusions from previous work that partly depleted western range lands can be improved and the stand of vegetation maintained without loss of forage through nonuse by the application of a system of "deferred and rotation" grazing. Additional data were secured on the adaptation of the principles of "deferred and rotation" grazing to grazing management on ranges where the forage crop reproduces vegetatively rather than primarily from seed. Special effort was concentrated upon working out plans for the extension of "deferred and rotation" grazing in its application to ranges within the national forests with a view to their maintenance under increased grazing permitted as an emergency measure during the period of the war. Good progress was made. Results at the Jornada Grazing Reserve were published in Department Bulletin 588, "Increased Cattle Production on Southwestern Ranges."

*Assignment.*—A. W. Sampson, L. H. Douglas, C. L. Forsling, R. L. Hensel.  
*Proposed expenditures, 1918-19.*—\$4,400.

### **Distribution and Economic Importance of Herbaceous and Shrubby Plants on Far-Western Ranges:**

*Object.*—The collection and identification of herbaceous and shrubby plants on national-forest ranges and the accumulation of notes on distribution, growth requirements, forage value, and objectionable qualities, to serve as a basis for (1) allotment of range to the class of stock for which it is best adapted, (2) proper adjustment of seasons of grazing, (3) determination of the grazing capacity of the range, (4) adjusting management to eliminate or decrease the loss of stock from stock-poisoning plants, (5) application of "deferred and rotation" grazing, and (6) general application of results from specific investigations. Efficient management of range lands necessitates a thorough knowledge of the vegetation which makes up the forage crop.

*Procedure.*—All members of the grazing investigative force make collections of plants and observations relative to their life history, natural requirements, and forage value in connection with the work of other projects. Local forest officers collect and submit specimens to secure identification and determine the forage value of each plant submitted. All plants are identified by the department, and notes are assembled and disseminated by members of the grazing investigative force of the Forest Service. This plan will be continued, and the data as rapidly as available will be disseminated among local forest officers and through them to stockmen by reporting on plant collections submitted for identification. Information will also be published from time to time.

*Cooperation.*—Office of Economic and Systematic Botany, Bureau of Plant Industry.

*Location.*—Collection of specimens and notes, on far-western ranges; identification of specimens and assembling of notes, at Washington, D. C.

*Date begun.*—1911.

*Results.*—(1) Prior to 1918: Approximately 31,000 specimens (about 4,700 species) were collected and identified and notes returned to collectors. The result is the gradual education of forest officers and stockmen as to the identification and value of the plants which make up the forage crop on approximately 100,000 acres of lands used for grazing within national forests, with a consequent improvement in the management of the grazing on these lands.

(2) During 1918: Approximately 4,500 specimens, including several new species, were collected during the year and notes for a large part of the collections furnished the collectors. Additional economic notes were collected in the field, and notes were compiled for about 300 species. Department Bulletin 545, "Important Range Plants," was published.

*Assignment.*—W. A. Dayton, Josephine L. Saunders.

*Proposed expenditures, 1918-19.*—\$5,000.



**Protection against Grazing:**

*Object.*—To determine the effect of grazing upon tree reproduction, erosion, and stream flow, and to work out methods of handling stock so as to minimize or eliminate unwarranted injury due to grazing.

*Procedure.*—The effect of grazing upon tree reproduction and the extent to which injury can be decreased by changes in grazing management and methods of handling stock in localities which are typical of large regions are studied. Areas are selected for study on cattle range, sheep range, and goat range to represent various conditions of slope, aspect, soil, vegetation, and different tree species. Numerous small plats are located, definitely marked, and all tree growth examined from two to four times during the year for a period of three to five years, depending upon species under consideration, class of stock, and range conditions; and thereafter reexaminations every three years for 10 to 15 years is proposed. Fenced areas are always provided to permit a comparative study of reproduction and vigor of reproduction under protection against grazing and under the existing systems of grazing. Grazing as a factor in causing erosion and floods from the high mountain lands is the major problem of the Great Basin Experiment Station in central Utah. Two areas comparable in every way are under comparative study—one under grazing and the other totally protected against grazing. All "run off," both water and sediment, is measured accurately, and all necessary meteorological data are collected throughout the year. The intensive study will be supplemented by general observations throughout the national forests.

*Cooperation.*—Office of Economic and Systematic Botany, Bureau of Plant Industry.

*Location.*—Coconino Forest, Ariz., Shasta Forest, Cal., Payette Forest, Idaho, Manti Forest, Utah, and Lincoln and Gila Forests, N. Mex., for specific studies; general observations throughout national forests.

*Date begun.*—1911.

*Results.*—(1) Prior to 1918: Major field work was completed in the study of sheep and cattle grazing on conifer timberlands, and suggestions for changes in management of range and stock are furnished to local forest officers. It has been found that, by care in placing cattle and sheep on ranges best suited to each class of stock and by improved methods of handling the stock, much of the damage done in the past to tree reproduction and to the forage crop and in starting erosion can be avoided. Suggested improvements are being put into practice in national-forest administration.

(2) During 1918: Observations in the study of grazing in relation to erosion were continued. Results prior to 1918 were published in Department Bulletin 675, "Range Preservation and Its Relation to Erosion Control on Western Grazing Lands."

The results prior to 1918 from the study of grazing in relation to yellow-pine reproduction in the Southwest were published in Department Bulletin 580, "Effects of Grazing upon Western Yellow-Pine Reproduction in the National Forests of Arizona and New Mexico." Observations on this study were continued with a view to further adjustment of grazing management to overcome the damage from grazing reported in Bulletin 580.

Minor observations were continued in the study on the effects of grazing upon the reproduction of aspen. A manuscript reporting results prior to 1918 and giving suggestions for the management of sheep grazing and cattle grazing in aspen forests was submitted for publication. The study has established the fact that sheep grazing may be responsible for unwarranted damage, in some cases amounting to complete destruction of aspen sprouts under three years of age. Cattle grazing does little damage to aspen reproduction if overgrazing and bad management of the stock are avoided.

Further data were collected in the study of goat grazing in relation to range and timber protection, and examinations were made of prospective goat ranges on the Santa Fe, Carson, Crater, Siskiyou, Siuslaw, Klamath, Shasta, and Lassen National Forests. These examinations were made with a view to extend production of goats on brush ranges suitable for goat grazing and not in use. A paper setting forth the



possibilities of goat production on new ranges was presented before the National Mohair Growers' Association, and short articles were published in the Angora Journal. A manuscript giving information relative to goat ranges and management of goats on the range is now being prepared for publication.

*Assignment.*—A. W. Sampson, R. R. Hill, W. A. Dayton, W. R. Chapline.

*Proposed expenditures, 1918-19.*—\$6,200.

### Methods of Handling Stock under Range Conditions:

*Object.*—To reduce to a minimum the waste of forage in utilizing the range and to minimize the cost of efficient handling both to stock owners and to the Forest Service. The work involves studies to determine the most satisfactory size of band, method of herding, salting, watering, and lambing in the case of sheep; and, for cattle, methods of control and handling throughout the grazing period.

*Procedure.*—The investigations on this project were begun with a band of sheep on a typical mountain summer sheep range placed under coyote-proof fence. A comparative study of handling under fence and handling under the old system of herding on open range was conducted through a period of four years to learn the natural habits of sheep under fence, the necessary restrictions in order to herd sheep successfully without fences on different kinds of range, and possible advantageous changes in existing methods of handling. These studies resulted in the "open-herding bedding-out" system of herding sheep. Studies since 1911 have aimed at working out variations in this system for different localities and at the same time have served to demonstrate the advantages of the new over the old system. All studies are made under practical range conditions and are always a comparative study of the existing systems and the methods proposed, in order that results will be conclusive both as to practical application and advantages of the new methods. The problem of range lambing has been attacked in the same way. Studies and demonstration tests along these lines are contemplated until all sheep on national-forest ranges are handled under the improved methods. In 1912 similar studies were started on a small scale with cattle. These studies have been materially broadened and made more comprehensive as regards different methods of handling and the advantages and disadvantages of each method, both to stock and range, by the investigations started during the summer of 1915 on the Jornada and Santa Rita Grazing Reserves in the Southwest.

*Cooperation.*—Office of Economic and Systematic Botany, Bureau of Plant Industry.

*Location.*—Absaroka, Beartooth, Helena, and Lewis and Clark Forests, Mont.; Gunnison and Cochetopa Forests, Colo.; Medicine Bow Forest, Wyo.; Caribou, Manti, Fillmore, Fishlake, and Sevier Forests, Utah; Inyo, Lassen, and Modoc Forests, Cal.; Datil Forest and Jornada Grazing Reserve, N. Mex.; and Santa Rita Grazing Reserve, Ariz.

*Date begun.*—1907.

*Results.*—(1) Prior to 1918: The "open-herding bedding-out" system of herding sheep was developed and put into application on approximately 50 per cent of the sheep ranges within national forests, with a resultant increase of 10 per cent in grazing capacity and 5 pounds increase in weight of lambs where the new system is followed. Improved methods of handling sheep under range conditions during the lambing season have proved efficient under practical application by sheep owners. Information of value has been obtained relative to drift and division fences, methods of salting, and distribution of water to control cattle on the range. Data on these subjects were published in Forest Service Circulars 156, 160, and 178, Forest Service Bulletin 97, and a number of papers in outside journals, especially a series of papers in the National Wool Grower beginning with the March, 1915, issue.

(2) During 1918: Application of improved methods of handling cattle on the Jornada Grazing Reserve during the past two years of drought have demonstrated the possibility of reducing loss from all causes, increasing the calf crop, and improving the grade of stock under the most unfavorable conditions. The results up to March, 1917, were published in Department Bulletin 588, "Increased Cattle Production on Southwestern Ranges." Results since March, 1917, have confirmed the conclusions in this bulletin.



During the year about 300 to 400 head of cattle were fed on a daily ration of 15 pounds of soap weed (*Yucca elata*) and 1 pound of cottonseed cake for about three months with excellent results. Stockmen in the Southwest have taken up this practice, and the soap weed is aiding greatly in carrying stock through the drought period.

Effort has been concentrated upon the application of improved methods of handling both cattle and sheep on the national-forest ranges as an emergency measure to provide for additional stock. Marked progress has been made in herding, salting, watering, and general handling of stock. In cooperation with the States Relations Service and State extension workers, over 100 illustrated lectures on improved range management have been delivered to audiences of stockmen who use the national-forest ranges. The most favorable reports from this work have been received.

Additional information relative to the handling of goats on the range was secured and will be included in a manuscript now under preparation for publication.

*Assignment.*—J. T. Jardine, F. D. Douthitt, C. L. Forsling, R. L. Hensel, R. R. Hill, Mark Anderson, L. C. Hurtt, J. L. Peterson, W. R. Chapline, L. H. Douglas.

*Proposed expenditures, 1918-19.*—\$8,300.

### **Distribution and Development of Stock-Watering Places:**

*Object.*—To determine the distribution of stock-watering places necessary for different classes of stock under various conditions of topography and forage, in order to properly utilize the range; and to collect data as to the best methods of developing stock-watering places under conditions existing throughout the western ranges.

*Procedure.*—Observations were made in 1913 on 700 watering places developed on national-forest ranges prior to that date, with a view to find out the methods most satisfactory for a given set of local conditions and to secure data relative to proper distribution of water under given conditions of topography, range, and class of stock. The conclusions were published in Farmers' Bulletin 592. Observations are being continued on projects developed prior to and since 1912. No special experiments are being conducted. In connection with the investigations conducted on the Jornada and Santa Rita Grazing Reserves in the Southwest, special study is being made to determine proper distribution of watering places as well as cost and methods of developing water on the semidesert ranges of the Southwest.

*Cooperation.*—Office of Economic and Systematic Botany, Bureau of Plant Industry.

*Location.*—Jornada and Santa Rita Grazing Reserves and national forests.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: Farmers' Bulletin 592 furnishes information as to the importance of properly distributed watering places to efficient range management and gives concise suggestions as to methods of developing and protecting watering places. The general result has been an aggressive effort on the part of forest officers and stock owners to develop adequate water for the maximum production of stock on available range, and good progress has been made. On the semidesert ranges of the Southwest watering places should not be more than approximately 3 miles apart to secure efficient use of the range, but on plains they may be 5 miles apart without great injury to range or stock.

(2) During 1918: Observations support previous conclusions as to the importance of well-distributed watering places on the range. Special examination of ranges hitherto unused or only partly used through lack of water for stock has resulted in developing water by methods not followed hitherto and in plans for future water development on other ranges.

*Assignment.*—J. T. Jardine, C. L. Forsling, R. L. Hensel.

*Proposed expenditures, 1918-19.*—\$660.

### **Eradication of Poisonous Plants:**

*Object.*—After information is furnished by the Office of Poisonous-Plant Investigations, Bureau of Animal Industry, as to the species which are poisonous to stock, the class of stock to which each species is poisonous, and the stage of growth at which it is poisonous, it is then necessary to



learn the distribution of each species throughout the national forests and to work out application of methods of protecting stock against poisoning. The distribution is gradually being determined through the project, "Distribution and Economic Importance of Herbaceous and Shrubby Plants on Far-Western Ranges." The object of the investigations under this project is to find out the most efficient methods of eradicating the poisonous plants, the conditions under which it is practicable to use sheep in removing larkspur annually from cattle ranges, and the conditions under which the cost of constructing drift or pasture fences as a protection against loss from poison is feasible; also to ascertain the extent to which poisonous-plant areas can safely be grazed if improved methods of handling are followed.

*Procedure.*—Actual eradication by cutting at different stages of growth and by digging up the plants are made under range conditions. Actual tests of grazing larkspur areas throughout the cattle range by sheep are being made. Many fences have been constructed, and the results in the way of eliminating loss are being observed. In all cases records are kept to determine the cost of preventive measures adopted as compared with the value of live stock saved from poisoning. It is planned during the coming year to extend the practical tests of eradicating larkspur to a number of ranges in Utah, Idaho, Montana, and Colorado, to continue the sheep-grazing tests, and to continue experiments on methods of eradication at the Great Basin Experiment Station.

*Cooperation.*—Office of Economic and Systematic Botany, Bureau of Plant Industry; Office of Poisonous-Plant Investigations, Bureau of Animal Industry; and stockmen on the national forests.

*Location.*—Forty-one national forests in Colorado, California, Idaho, Arizona, Utah and Wyoming.

*Date begun.*—1912.

*Results.*—(1) Prior to 1918: It was shown that under certain conditions eradication of tall larkspur by grubbing out the plants is practicable; that loss of cattle from larkspur poisoning can be eliminated under certain conditions where the larkspur patches can be grazed off by sheep before the cattle are put on the range; that loss of sheep can be decreased by following the "bedding-out" system of herding; and that construction of drift fences is a matter of economy under some conditions. During 1917 practical tests of eradicating larkspur by digging it up were made in cooperation with cattlemen on ranges in California, Colorado, Utah, and Idaho and show this method to be justified on many ranges by the reduction in losses of cattle. Additional ranges were examined and plans for eradication of larkspur during the summer of 1917 prepared.

(2) During 1918: Eradication of larkspur by grubbing was continued on a larger scale than previously on national forests of Colorado, California, Idaho, and Utah, in cooperation with stockmen. To date a total of over 1,900 acres of larkspur have been grubbed out at a cost of about \$11,000. The grubbing has eliminated or reduced to a few animals the loss of cattle from larkspur poisoning on about a quarter of a million acres of national-forest range. The value of the stock lost annually from larkspur poisoning prior to grubbing on the areas within 9 forests upon which grubbing has been done amounted to about \$16,000, based on present prices. Results on 7 other forests where grubbing has been done were considered equally good, but no reliable figures on previous losses are available. Additional areas were examined and plans made for extending the grubbing work in 1919. That the results have been of extremely practical value is shown by the willingness of stockmen to cooperate to the extent of labor and money, averaging about one-half the total cost of the eradication. Results prior to 1918 and suggestions for eradication work in future were published in *Farmers' Bulletin* 826, "Eradicating Tall Larkspur on Cattle Ranges in National Forests."

*Assignment.*—J. T. Jardine, A. W. Sampson.

*Proposed expenditures, 1918-19.*—\$2,800.

### **Climatic Characteristics of Vegetative Belts on the Manti Forest:**

*Object.*—To obtain and correlate exact measurements of climatic factors which limit the distribution of species and bring about distinct plant formations or vegetative types locally on the Manti Forest.



*Procedure.*—It is proposed to make observations in the oak, aspen, and Engelmann spruce associations at 7,000 feet, 8,700 feet, and 10,000 feet, respectively, under similar conditions of slope and exposure. The following factors will be recorded throughout the season: Air temperatures by thermographs; soil temperatures, 6, 12, and 24 inches deep, read at 8 a. m. and 6 p. m.; soil moisture, 10-day periods, at 6, 12, and 24 inch depths; evaporation by means of the Livingston porous-cup atmometer and by exposure of free water surface; precipitation throughout the year with tipping bucket and standard rain gauges, and by snow-scale measurements and water-content determinations of snow.

*Cooperation.*—Weather Bureau; Office of Economic and Systematic Botany, Bureau of Plant Industry.

*Location.*—Great Basin Experiment Station, Manti Forest, Utah.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: Observation stations were selected, equipment installed, and records of all factors secured for approximately three years. For every increase of 1,000 feet in altitude the time at which growth begins is later by approximately 10 days.

(2) During 1918: Records were secured for all factors previously studied. A manuscript discussing the relation of climate to plant growth was submitted for publication.

*Assignment.*—A. W. Sampson.

*Proposed expenditures, 1918-19.*—\$700.

**Total, Range Investigations, \$35,280, including \$1,920 statutory. This does not include an unallotted contingent of \$1,640.**

#### [Regulation.]

### PLANTING ON NATIONAL FORESTS.

#### Reforestation:

*Object.*—To reforest national-forest areas entirely denuded or scantily covered with forest growth; also to secure seed and to maintain nurseries for the production of planting stock.

*Procedure.*—The work is planned and conducted on the basis of restocking annually approximately 10,000 acres by planting and 2,500 acres by direct seeding. Permanent Forest Service nurseries produce the required amount of stock for planting. Native seed is collected from the national forests, and exotic seed, of which but a small supply is used for planting stock in the nurseries, is purchased.

*Location.*—Washington, D. C., district offices, and national forests.

*Date begun.*—1901.

*Results.*—During the fiscal year 1917, 191 acres of national-forest land were sown to tree seed and 7,491 acres planted.

*Assignment.*—W. B. Greeley, E. E. Carter, district foresters, and forest supervisors.

*Proposed expenditures, 1918-19.*—\$147,700, including \$2,000 statutory.

#### [Research.]

### SILVICULTURAL INVESTIGATIONS.

#### Dendrological Studies:

*Object.*—(1) To bring together in a comprehensive manner all the available information on common names, geographical distribution, botanical characteristics, occurrence, and habits of forest trees by groups or genera; (2) to secure new information concerning the distinguishing characteristics and geographical distribution of North American trees and shrubs.

*Procedure.*—New data are secured through collections of local forest officers, by examination of the various herbaria in the United States, and by the actual field work of the men directly charged with the dendrological studies. During 1919 it is planned to issue publications on certain of the hardwoods of the Rocky Mountain region.

*Cooperation.*—National Herbarium.

*Location.*—Washington, D. C.

*Date begun.*—1886.



*Results.*—(1) Prior to 1918: Range maps have been prepared for many of the eastern tree species and for practically all important tree species native to the western United States. An atlas on the pines, an unnumbered bulletin on "The Forest Trees of the Pacific Slope," Department Bulletins 207, "The Cypress and Juniper Trees of the Rocky Mountain Region," and 327, "The Spruce and Balsam Fir Trees of the Rocky Mountain Region," have also been published.

(2) During 1918: Department Bulletin 680, "Miscellaneous Conifers of the Rocky Mountain Region," was published; 32 maps of the tree species were prepared, some 2,500 new range notes added to the records, and about 275 dendrological identifications made.

*Assignment.*—George B. Sudworth, W. H. Lamb, Georgia E. Wharton.

*Proposed expenditures, 1918-19.*—\$8,000.

## Forestation Studies:

### (a) SEED STUDIES—

*Object.*—To determine the best methods of seed extraction, comparative germination of seed in greenhouse and field, seed production, and the effect of source of seed upon the resulting stock for most of the important timber trees of the western national forests.

*Procedure.*—Samples of seed collected on the various national forests are tested in the greenhouses of the experiment stations to determine their germinability, and at several of the stations seeds are also extracted directly from the cones, and the temperature most favorable for the rapid opening of the cones without injury to the viability of the seed is determined. Studies of the effect of source of seed upon the resulting stock are conducted by means of sample plots. Twelve experiments were under way during the past year.

*Location.*—Forest experiment stations and nurseries on the national forests.

*Date begun.*—1910.

*Results.*—(1) Prior to 1918: As a result of previous work a fund of useful information is now available regarding the characteristics and behavior of the seed of all the important western species.

(2) During 1918: Much new information was secured on the best methods of seed extraction and on the importance of source of seed.

*Assignment.*—C. G. Bates, G. A. Pearson, J. V. Hofmann.

*Proposed expenditures, 1918-19.*—\$5,315.

### (b) NURSERY PRACTICE—

*Object.*—To determine for the principal species of timber trees on the western national forests the best amount of seed to sow, time of sowing, depth of covering seed, methods of sowing, fertilizing, shading, watering, cultivation, and root development, time and method of transplanting, and methods of retarding spring growth in nursery stock.

*Procedure.*—Small experiments are conducted at the nurseries of the experiment stations as well as at the large administrative nurseries, which have been established primarily for the raising of stock for planting on the national forests. A number of experiments are now under way.

*Location.*—All forest experiment stations and nurseries.

*Date begun.*—1910.

*Results.*—(1) Prior to 1918: Experiments have resulted in the accumulation of sufficient detailed data to place on a solid basis the growing of nursery stock on a large scale.

(2) During 1918: Progress has been made in all lines under investigation, particularly with reference to time of sowing, shading, and fertilizing.

*Assignment.*—C. G. Bates, G. A. Pearson, E. N. Munns, J. F. Kummel, C. F. Korstian.

*Proposed expenditures, 1918-19.*—\$10,210.

### (c) SOWING AND PLANTING STUDIES—

*Object.*—To determine for the most important species of timber trees on the western national forests the best season and methods for sowing and planting in the field, the classes of stock to use, and the sites most suitable to the different species.

*Procedure.*—Small sample plats are located at the experiment stations, and experiments are also conducted in connection with the large-scale reforestation operations of the national forests. A large number of studies are now under way.



*Location.*—Forest experiment stations on the national forests and a number of forests where reforestation work is conducted.

*Date begun.*—1910.

*Results.*—(1) Prior to 1918: Experiments have resulted in an improvement of the reforestation work on the national forests, both in the discarding of poor methods and in the development of good methods.

(2) During 1918: Marked progress was made along all lines under investigation, particularly with reference to size and age of stock and season of sowing.

*Assignment.*—C. G. Bates, G. A. Pearson, J. F. Kummel, C. F. Korstian.

*Proposed expenditures, 1918-19.*—\$10,210.

### Studies of Forest Influences:

*Object.*—To determine the relation of forests to climate, stream flow, agriculture, and permanent community development, and also to obtain data necessary for a proper understanding of all silvicultural experiments in which the climatic factor enters into the results.

*Procedure.*—At the six experiment stations meteorological observations are being carried on in various forest types. The results of these observations are correlated with those on forest cover. At the Wagon Wheel Gap station the relation of forest cover to stream flow is given the main attention. The problem is studied on two adjacent watersheds, one of which is to be denuded and the other left under forest cover. Five studies are now under way.

*Cooperation.*—Weather Bureau.

*Location.*—Forest experiment stations.

*Date begun.*—1910.

*Results.*—(1) Prior to 1918: Previous work has resulted in the accumulation of a large amount of data on the climatic characteristics of forest types and their influence on their environment. Two articles, "A meteorological study of parks and timbered areas in the western yellow-pine forests of Arizona and New Mexico" and "Influences of a western yellow-pine forest on the accumulation and melting of snow," were published in the Monthly Weather Review for October, 1913, and March, 1915.

(2) During 1918: Much additional information was secured upon the climatic characteristics of the most important forest types in the national forests, particularly northwestern Idaho, California, and the central Rocky Mountains. The effects of forests on irrigation were also studied.

*Assignment.*—C. G. Bates, J. A. Mitchell, G. A. Pearson.

*Proposed expenditures, 1918-19.*—\$8,800.

### Forest-Management Studies:

*Object.*—To determine the best methods of cutting in different forest types in order to secure natural reproduction in the shortest possible time, and to improve the quality and productivity of the stand.

*Procedure.*—In connection with the timber sales on the national forests sample plots are cut under different silvicultural methods and the effect on the natural reproduction studied. Studies are also made of reproduction on cut-over and burned-over land. Thirty-four studies are now under way.

*Location.*—Forest experiment stations and national forests.

*Date begun.*—1912.

*Results.*—(1) Prior to 1918: Previous work has resulted in the modification of methods of cutting timber on the national forests so as to insure natural reproduction following cutting.

(2) During 1918: The study of the southern Appalachian region of the eastern United States was continued and further results accomplished. The study in the southern Appalachians has added to the knowledge acquired in the previous year's work and has enabled the Forest Service to still further adapt its system of cutting for that region so that the best silvicultural results will be obtained. The particular result which will be obtained from such studies is that the Forest Service will finally be able to work out a system of American silviculture for Government, State, and private timberlands.

*Assignment.*—Raphael Zon, C. G. Bates, G. A. Pearson, J. V. Hofmann, E. H. Frothingham.

*Proposed expenditures, 1918-19.*—\$12,420.



**Volume, Growth, and Yield Studies:**

*Object.*—To secure reliable data as to the volume, growth, and yield of the different species and types of forests as a basis for the proper handling of timber sales, management of forests, and determination of the damage caused by fire, trespass, etc. This information will also form the basis for the establishment of certain laws of tree growth.

*Procedure.*—Measurements of volume, growth, and yield are secured chiefly in connection with the timber sales on the national forests, as well as by periodic measurement of trees in permanent sample plots.

*Location.*—Washington, D. C., forest experiment stations, and national forests.

*Date begun.*—This work dates from the beginning of the Division of Forestry (1886), but has received more impetus within the last five years.

*Results.*—(1) Prior to 1918: Altogether there have been prepared some 1,850 tables of volume, growth, and yield covering 100 different species. In addition, there have been established over 300 sample plots in the various forest regions of the United States for the study of growth and yield of stands.

(2) During 1918: Nine additional volume, growth, and yield tables were made.

*Assignment.*—J. W. Stokes, C. G. Bates, T. T. Munger, W. D. Sterrett.

*Proposed expenditures, 1918-19.*—\$8,650.

**Protection Studies:**

*Object.*—To determine the best methods of protecting standing timber and natural reproduction from damage by fire, grazing, disease, insects, animals, and climatic agencies, such as snow, hail, and wind.

*Procedure.*—The work is done in cooperation with several bureaus of the department. The Office of Forest Pathology, of the Bureau of Plant Industry, has assigned forest pathologists to three national-forest districts (Districts 1, 3, and 5), in addition to one pathologist specializing in nursery diseases who looks after the nurseries of all the districts. The forest pathologists are under the supervision of the Office of Forest Pathology but work on problems which are most urgent in the management of the national forests.

*Cooperation.*—Weather Bureau and Bureaus of Plant Industry, Entomology, and Biological Survey.

*Location.*—Forest experiment stations and national forests.

*Date begun.*—1910.

*Results.*—(1) Prior to 1918: In general, the work to date has resulted in modifying and greatly improving the efficiency of the protection afforded the national forests against fire, insects, and disease.

(2) During 1918: The most important feature of the work has been the continuation of a comprehensive study of the forest-fire hazard and liability on the national forests, with special reference to the equitable distribution of fire-fighting funds on the basis of the value of the forest resources and the danger of their destruction.

*Assignment.*—James R. Weir, Carl Hartley, W. H. Long, and E. P. Meinicke, Bureau of Plant Industry; W. N. Sparhawk and S. B. Show, Forest Service.

*Proposed expenditures, 1918-19.*—\$2,900.

**Tree Studies:**

*Object.*—To secure information concerning the characteristics and life histories of the important forest trees of this country as a basis for their proper management.

*Procedure.*—This information is collected largely in connection with the timber-sales work on the national forests, management studies, planting studies, studies of forest types, and similar studies. It is mainly a compilation of all the available information on the important timber trees of the United States. Studies of five species are now in progress.

*Location.*—Washington, D. C., and district headquarters.

*Date begun.*—1886.

*Results.*—(1) Prior to 1918: Previous work has resulted in the publication of bulletins or silvical leaflets on most of the important timber trees of the United States.

(2) During 1918: Several important studies were under way and the following publications issued: Department Bulletins 544, "The Red Spruce," and 604, "Incense Cedar."

*Assignment.*—Raphael Zon, E. H. Frothingham, W. D. Sterrett.

*Proposed expenditures, 1918-19.*—\$8,050.

### Wood-Lot Studies and Demonstrations:

*Object.*—To bring about better marketing of wood-lot products by wood-lot owners and also the better silvicultural handling of wood lots.

*Procedure.*—After a study of existing conditions in a State, a report will be published in cooperation, whenever possible, with that State, covering principally the subject of marketing woodland products. These reports will be available to the two extension specialists in forestry who have been transferred from the Forest Service to the States Relations Service. These extension specialists in forestry, working through the extension services of the various States, will bring home to the wood-lot owners the points essential for them to keep in mind in disposing of their wood-lot products and also in the better handling of their timber from a silvicultural standpoint. In general, they will attempt to develop interest in the farm wood-lot problem and point out to the State director the advantage of attaching to his staff a forester, and, where it appears desirable in starting the work, will give demonstrations in marketing wood-lot products and in silvicultural practice. In giving such demonstrations the work will always be carried on in cooperation with the county agricultural agent.

*Cooperation.*—Through the States Relations Service with extension departments of State agricultural colleges and State foresters; and also, wherever possible, with boards of trade, farmers' unions, and any other organizations interested in the welfare of the farmer.

*Location.*—Headquarters at Washington, D. C. (See also "Results.")

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: The work has been conducted in the States of Michigan, Wisconsin, Minnesota, Ohio, Indiana, Illinois, Missouri, Kentucky, Tennessee, Maine, South Carolina, and Georgia. Reports upon the marketing of wood-lot products have been published by Michigan, Indiana, and Kentucky. Three general Farmers' Bulletins, "Care and Improvement of the Wood Lot," "Measuring and Marketing Wood-Lot Products," and "Status and Value of Farm Wood-Lot Products," have been issued.

(2) During 1918: Work was conducted in North Carolina and West Virginia. Reports upon the marketing of wood-lot products in Georgia and Maine were published by those States, and a report on West Virginia was prepared, which will be published by that State.

*Assignment.*—C. R. Tillotson, G. N. Lamb.

*Proposed expenditures, 1918-19.*—\$4,300.

### Farm Wood-Lot Management Survey:

*Object.*—To secure data over a wide range of the wood-lot section of the United States which will bring out the actual and relative importance of the farm wood lot in the general scheme of farm management.

*Procedure.*—Three typical sections of the country will be visited, in each of which 50 to 75 farms will be inspected and certain data obtained which will bring out the foregoing points.

*Cooperation.*—Office of Farm Management.

*Location.*—Headquarters at Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: The data already obtained indicate that for the regions studied the wood lot is valuable as an integral part of the farm and often a most important source of income.

(2) During 1918: Data were secured for North Carolina, South Carolina, Alabama, Tennessee, Louisiana, and Missouri.

*Probable date of completion.*—The survey was completed during 1918. The report is now being prepared.

*Assignment.*—E. R. Hodson.

*Proposed expenditures, 1918-19.*—\$2,250.



**Forest Service Library:**

*Object.*—Upkeep of Washington, district, supervisors', and forest experiment-station libraries.

*Procedure.*—Selecting books with the assistance of the library committee, both for the Washington and field libraries; indexing all books received and all periodical articles of interest to the Forest Service; indexing all manuscript reports prepared in the service; preparing a monthly bibliography of current literature and special bibliographies on request; circulating books and periodicals throughout the Washington office; keeping a record of all books and periodicals furnished to field libraries.

*Cooperation.*—Main department library, Library of Congress, and other Government libraries.

*Location.*—Washington, D. C., district headquarters, national forests, and forest experiment stations.

*Date begun.*—1899.

*Results.*—During the year 1918, 610 books and pamphlets were added to the Washington library and 280 books were sent to field libraries. A total of 19,713 publications are now included in the Washington library and 30,848 in field libraries.

*Assignment.*—Raphael Zon, H. E. Stockbridge.

*Proposed expenditures, 1918-19.*—\$2,500.

**Computation:**

*Object.*—Computation of field measurements and various other miscellaneous data for the entire Forest Service.

*Procedure.*—The data secured by the field force are worked up by the computing clerks in accordance with definite written instructions under the supervision of a technical forester.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—During the fiscal year 1918, 5,000 forest measurements were worked up. These were elaborated into 3 volume, 4 growth, and 2 miscellaneous tables; 1,016 copies of tables were distributed in answer to inquiries from lumbermen, timberland owners, and foresters. Some 1,860 tables have now been prepared covering with varying degrees of thoroughness all the important timber trees of the United States.

*Assignment.*—J. W. Stokes.

*Proposed expenditures, 1918-19.*—\$12,493.

**Development of Private Forestry:**

*Object.*—Development of such lines of improved management through suggestion, experiment, and demonstration as may be found practicable without attempting elaborate or comprehensive working plans.

*Procedure.*—This work consists in keeping in constant touch with timberland owners and operators in the more important regions, attending their meetings, cultivating their acquaintance, making arrangements for experiments and demonstrations when practicable, and giving suggestions and advice on specific improvements in handling timberlands or conducting logging operations and the like.

*Location.*—Washington, D. C.

*Date begun.*—1898.

*Results.*—Examination has been made of a large number of tracts where forestry is now being practiced.

*Assignment.*—Austin Cary.

*Proposed expenditures, 1918-19.*—\$4,400.

**State Cooperation:**

*Object.*—To assist States in conserving their forest resources and to compile and codify State forestry laws.

*Procedure.*—Correspondence is conducted with State officials, and field examinations and reports on special problems are made. Laws are codified according to subjects showing what the State has or has not done in the way of forestry legislation.

*Cooperation.*—State forestry departments, private forestry associations, and similar organizations.

*Location.*—Washington, D. C.

*Date begun.*—1898.

*Results.*—A large number of States have been encouraged to adopt sound forest policies through the passage of progressive legislation. The compilation of State forestry laws has had wide educational results and has shown which States have adopted the most advanced and practical forestry laws.

*Assignment.*—J. G. Peters, L. S. Murphy, J. A. Mitchell, J. S. Peyton.  
*Proposed expenditures, 1918-19.*—\$5,870.

**Total, Silvicultural Investigations, \$106,368, including \$27,640 statutory.**

[Regulation.]

## RECONNOISSANCE OF RESOURCES.

### Timber Surveys:

*Object.*—To determine national-forest timber resources, particularly available timber supplies.

*Procedure.*—Under organized crews estimates of the standing timber are made, silvical and logging data essential to timber sales secured, and topographic and cultural data obtained for base maps of the area.

*Location.*—Washington, D. C., district offices, and national forests.

*Date begun.*—1905.

*Results.*—During the fiscal year 1917 estimates, surveys, maps, and detailed data on the character and condition of the timber and methods of exploitation were obtained for 800,159 acres of national-forest land.

*Assignment.*—W. B. Greeley, E. E. Carter, district foresters, and forest supervisors.

*Proposed expenditures, 1918-19.*—\$67,300.

### Range Reconnaissance:

*Object.*—To determine the grazing capacity of the range and to work out and apply plans for grazing management and range development and improvement.

*Procedure.*—The following data are secured and compiled in the form of maps with notes: (1) The kind of stock for which a range is best suited; (2) the location of unused, partially used, and overgrazed range, and the changes necessary to bring about proper use; (3) the location of poison-plant areas and areas infested with range-destroying rodents; (4) the location and availability of possible sources of water supply; and (5) the proper grazing season for the range.

*Cooperation.*—Bureaus of Plant Industry and Biological Survey.

*Location.*—National forests.

*Date begun.*—1907.

*Results.*—See "Grazing" results under "National Forest Administration."

*Assignment.*—J. T. Jardine, L. H. Douglas, R. R. Hill, Mark Anderson, F. D. Douthitt, L. C. Hurtt, J. L. Peterson.

*Proposed expenditures, 1918-19.*—\$35,000.

**Total, Reconnaissance of Resources, \$102,300, including \$2,300 statutory.**

[Research.]

## PREPARATION AND MAINTENANCE OF GRAPHIC, PHOTOGRAPHIC, AND STATISTICAL RECORDS, AND PUBLICATION OF RESULTS.

### Maps and Surveys:

*Object.*—Preparation and supervision of forest maps, surveys, and photographic work and compilation of forest statistics.

*Procedure.*—The Office of Maps and Surveys includes the Sections of Atlas, Drafting, Engraving, Surveys, and Photography. Topographic and outline maps for use in the administration of the national forests are prepared from field sheets or notes and the lithographing of the maps is performed in the Geological Survey plant. Negatives taken in the field by forest officers are developed and photoprints made therefrom upon requisition and approval by the proper officials. Statistics of various administrative transactions are annually called for from each forest for compilation and preservation in permanent volumes of the forest atlas.

*Cooperation.*—Geological Survey, General Land Office, Coast and Geodetic Survey, and Census Bureau.



*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—(1) Prior to 1918: The first administrative maps of the national forests were merely hasty compilations of such data as were already available, chiefly in the form of township plats of the General Land Office and topographic quadrangles of the Geological Survey. These were made up in folios on a scale of 1 inch to the mile, six townships to the page, and in three colors. This original atlas is being revised, and, in addition, forest maps in color on a half-inch scale and forest base maps in black on a quarter-inch scale are being prepared.

(2) During the fiscal year 1918, 1,223 forest and title classification and silvicultural maps and 645 topographic and outline maps were prepared, 1,154 miscellaneous drawings made, and 200,000 copies of forest maps printed. The Section of Photography made or developed 8,444 negatives, made 32,565 photo-view prints and 2,726 lantern slides, mounted 4,293 prints and 49,885 square feet of maps, and printed by the various processes 123,251 square feet of maps, diagrams, illustrations, etc.

*Assignment.*—C. A. Kolb.

*Proposed expenditures, 1918-19.*—\$63,920.

### Editorial Work:

*Object.*—Supervision and conduct of activities for diffusing a general knowledge of the principles and practice of forestry, preparation of Forest Service manuscripts for publication, proof reading, handling of requests for publications and of job printing, and development, custody, and use of exhibit material, lantern slides, and motion pictures.

*Procedure.*—Information of educational value is diffused through exhibits, motion pictures, addresses, the press, and cooperation with educators, schools, and institutions. Manuscripts for publication are given a technical and literary review.

*Cooperation.*—Exposition authorities desiring the use of exhibit material and teachers and others desiring the use of lecture materials, sets of photographs, wood samples, charts, maps, etc., for purposes of public instruction.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Results.*—In 1918 the office prepared for official publication 34 manuscripts; cared for all printing matters; distributed information; made 256 loans of lantern slides, 15 loans of exhibit material, and 126 loans of sets of photographs and wood sections to school and library authorities; and colored 1,731 lantern slides and 61 bromides.

*Assignment.*—Herbert A. Smith, Paul D. Kelleter, L. C. Everard.

*Proposed expenditures, 1918-19.*—\$36,180.

**Total, Preparation and Maintenance of Graphic, Photographic, and Statistical Records, and Publication of Results, \$100,000, including \$68,820 statutory.**

[Regulation.]

## IMPROVEMENT OF THE NATIONAL FORESTS.

### Improvements:

*Object.*—Construction and repair of roads, trails, telephone lines, fire-breaks, fences, corrals, buildings, bridges, water improvements, etc.

*Procedure.*—Forest supervisors recommend improvement projects regarded as necessary for national-forest administration, and after approval by the district forester the work is performed under the immediate supervision of the supervisor and the local ranger force and such specialized assistants as can be furnished from the district forester's office.

*Cooperation.*—States, counties, telephone companies, and other organizations in the construction and maintenance of roads, trails, telephone lines, etc.

*Location.*—National forests.

*Date begun.*—1907.

*Results.*—The estimated value of permanent improvements on the national forests at the close of the fiscal year 1917 was \$6,787,311. These include 2,919.41 miles of road, 25,197.38 miles of trails, 23,117.98 miles of



telephone lines, 866.77 miles of firebreaks, and 2,153 field quarters, besides miscellaneous improvements constructed for protection purposes and to assist in the administration of the grazing business. In addition to facilitating administration and increasing protection with lower operating cost, the construction of permanent improvement on the forest has resulted in direct and immediate public benefit by making accessible and usable a large acreage of country which otherwise would not have been opened up for many years.

*Assignment.*—H. S. Graves, district foresters, and forest supervisors.

*Proposed expenditures, 1918-19.*—\$450,000.

[Regulation.]

## COOPERATIVE FIRE PROTECTION (WEEKS LAW).

### Cooperative Fire Protection:

*Object.*—To cooperate in the protection from fire of the forested watersheds of navigable streams, under section 2 of the Weeks law (Mar. 1, 1911).

*Procedure.*—An agreement is made with each State, under which Federal expenditures are incurred for the employment of forest-fire patrolmen, provided the State expends at least an equal amount for fire-protection purposes.

*Cooperation.*—States of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Maryland, Virginia, West Virginia, Kentucky, North Carolina, Louisiana, Texas, Michigan, Wisconsin, Minnesota, South Dakota, Montana, Idaho, Washington, and Oregon.

*Location.*—Washington, D. C.

*Date begun.*—1911.

*Results.*—Approximately 14,000,000 acres of forest land have been protected from fire, and the people have been educated to the needs of fire protection.

*Assignment.*—J. G. Peters, L. S. Murphy, J. A. Mitchell.

*Proposed expenditures, 1918-19.*—\$100,000.

[Regulation.]

## ROADS AND TRAILS FOR STATES.

### Road Construction under the 10 Per Cent Appropriation:

*Object.*—Construction and maintenance of roads, trails, and bridges within the national forests for the purpose of opening new territory to settlement and of providing means of communication and transportation to settlers within or adjacent to the national forests.

*Procedure.*—General plans for road construction are prepared for each State to which the appropriation is applicable. Roads are constructed in the order of their importance as fast as funds are available.

*Cooperation.*—Bureau of Public Roads, State, county, and other local governments, corporations, associations, and individuals.

*Location.*—All national-forest States and Alaska.

*Date begun.*—1912.

*Results.*—From 1912 to 1917 about 1,525 miles of road and a considerable number of bridges have been constructed or repaired. In recent years the greater portion of the appropriation has been used in new construction. Approximately 190 miles of road were constructed or repaired during the calendar year 1917.

*Assignment.*—T. W. Norcross and district engineers of Forest Service.

*Proposed expenditures, 1918-19.*—\$151,500.

### Road Construction under Section 8 of the Federal-Aid Road Act:

*Object.*—Survey, construction, and maintenance of roads and trails within or only partly within the national forests when necessary for the use and development of resources upon which communities within and adjacent to the national forests are dependent.

*Procedure.*—Applications for cooperation in road construction are filed with the district foresters by the proper officers of the State or county concerned. Applications are examined, working plans for the several States prepared, terms of cooperation arranged with applicants, cooperative agreements executed by the applicants and by the Secretary of Agricul-



ture, and allotments made to the several projects. When financial arrangements have been made and cooperative agreements signed, the work of survey and construction is turned over to the Bureau of Public Roads for execution.

*Cooperation.*—Bureau of Public Roads, States, and counties.

*Location.*—All national-forest States and Alaska.

*Date begun.*—1916.

*Results.*—Maps and tabulations showing a comprehensive road system for the national forests and immediate vicinity have been prepared. Administrative examinations have been made of all projects for which applications have been filed as required by the law. Cooperative agreements have been executed or negotiations authorized for agreements as follows: Location survey, plans, and estimates for 11 projects, length 460 miles; estimated total cost (to Federal Government and cooperators), \$73,339. Construction and maintenance: Four projects, 64 miles; total cost, \$356,785. Survey, construction, and maintenance: 38 projects 882 miles in length; total cost, \$3,339,841. Totals: 53 projects, 1,346 miles; estimated total cost, approximately \$3,770,000.

*Assignment.*—T. W. Norcross and district engineers of Forest Service.

*Proposed expenditures, 1918-19.*—\$15,420.

**Total, Roads and Trails for States, \$166,920.**

[Regulation.]

## ACQUISITION OF LANDS UNDER THE WEEKS LAW.

### Examination and Purchase:

*Object.*—To acquire lands for national-forest purposes on the headwaters of important navigable streams.

*Procedure.*—Twenty-one purchase areas, comprising 8,450,000 acres, have been designated, within 18 of which the Forest Service invites proposals of land, examines and values tracts which are offered, and recommends purchases to the National Forest Reservation Commission, which approves and fixes the prices to be paid, after which the lands are surveyed and the titles examined.

*Cooperation.*—Under the act of March 1, 1911, the Geological Survey is required to examine lands considered for purchase and to show whether they are influential in the protection of the navigability of navigable streams. After approval by the National Forest Reservation Commission the Office of the Solicitor conducts the title examinations and submits reports upon titles to the Attorney General, who must approve the titles to all lands before they can be acquired.

*Location.*—Lands are being acquired in the following purchase areas, with headquarters as stated:

### PURCHASE AREAS.

State.	Name of area.	Headquarters.
Alabama.....	Alabama.....	Moulton, Ala.
Arkansas.....	{ Arkansas.....	Hot Springs, Ark.
	{ Ozark.....	Harrison, Ark.
Georgia.....	Georgia.....	Blue Ridge, Ga.
Do.....		
North Carolina.....	{ Savannah.....	Clayton, Ga.
South Carolina.....		
Maine.....		
New Hampshire.....	{ White Mountain.....	Gorham, N. H.
	{ Boone.....	Marion, N. C.
North Carolina.....	{ Mount Mitchell.....	Do.
	{ Pisgah.....	Asheville, N. C.
Do.....	{ Nantahala.....	Clayton, Ga.
Tennessee.....	{ Unaka.....	Johnson City, Tenn.
	{ Cherokee.....	Blue Ridge, Ga.
Virginia.....	{ Massanutten.....	Harrisonburg, Va.
	{ Natural Bridge.....	Buena Vista, Va.
Do.....		
Tennessee.....	{ White Top.....	Johnson City, Tenn.
Virginia.....	Potomac.....	Harrisonburg, Va.
West Virginia.....	Shenandoah.....	Do.
Do.....	Monongahela.....	Elkins, W. Va.

*Date begun.*—1911.

*Results.*—To June 30, 1918, 1,650,790 acres had been approved for purchase at an average price of \$5.25 per acre, involving an expenditure of \$9,307,981.66. Title had vested in the United States to 1,119,137.18 acres, at an average price of \$5.58 per acre, or an expenditure of \$6,240,907.01. During the year it was necessary, on account of defective titles, to drop from consideration 34,766 acres which had previously been approved for purchase by the commission; consequently, although the purchase of 185,199 acres, at an average price of \$5.12 per acre, was authorized, the net increase was only 150,433 acres.

*Assignment.*—William L. Hall, W. W. Ashe, A. H. McConville.

*Proposed expenditures, 1918-19.*—\$546,596, including \$3,600 statutory. This total also includes \$70,000, more or less, allotted to the Solicitor's office. (The total amount available on July 1, 1918, from unexpended balances of former annual appropriations for the acquisition of land under the Weeks law was \$1,102,180.33.)

#### ALLOTMENTS OF FOREST SERVICE APPROPRIATIONS BY UNITS OF ORGANIZATION.

##### Washington, D. C.:

General office and field work	\$454, 582
Madison laboratory	201, 070
Supply depot and property audit	181, 270
Appalachian (excluding land purchase)	146, 316
State cooperative fire protection	65, 550
Federal-aid roads (sec. 8)	5, 420
<b>Total</b>	<b>1, 054, 208</b>

##### District 1, Missoula, Mont.:

District office and field work	104, 510
National forests—	
Absaroka	19, 576
Beartooth	17, 524
Beaverhead	20, 901
Bitterroot	20, 886
Blackfeet	22, 537
Cabinet	26, 570
Clearwater	29, 178
Coeur d'Alene	49, 289
Custer	10, 070
Deerlodge	40, 288
Flathead	46, 208
Gallatin	16, 389
Helena	18, 707
Jefferson	28, 030
Kaniksu	29, 519
Kootenai	30, 779
Lewis and Clark	18, 523
Lolo	22, 311
Madison	12, 898
Missoula	18, 961
Nez Perce	29, 228
Pend Oreille	25, 570
Saint Joe	31, 345
Selway	35, 804
Sioux	10, 732
Reserve (fire protection, etc.)	3, 859
Land classification	7, 090
Entry surveys	19, 000
Timber survey	7, 000
Grazing reconnoissance	5, 400
Silvical investigations	2, 760
Planting	48, 351
Products investigations	1, 400
Improvements	96, 576
Grazing investigations	1, 900
State cooperative fire protection	6, 300
Roads and trails for States	47, 894
Federal-aid roads (sec. 8)	700
<b>Total</b>	<b>984, 563</b>

##### District 2, Denver, Colo.:

District office and field work	\$85, 510
National forests—	
Arapahoe	17, 382
Battlement	12, 680
Bighorn	18, 682
Black Hills	31, 629
Cochetopa	16, 516
Colorado	22, 405
Durango	14, 313
Gunnison	19, 123
Harney	22, 053
Hayden	12, 320
Holy Cross	19, 350
Leadville	16, 497
Medicine Bow	21, 100
Michigan	8, 090
Minnesota	10, 145
Montezuma	16, 732
Nebraska	10, 620
Pike	27, 911
Rio Grande	20, 709
Routt	17, 187
San Isabel	16, 045
San Juan	12, 813
Shoshone	19, 740
Sopris	17, 915
Superior	25, 992
Uncompahgre	20, 766
Washakie	15, 770
White River	19, 784
Reserve (fire protection, etc.)	4, 032
Land classification	4, 000
Entry survey	16, 800
Timber survey	9, 910
Grazing reconnoissance	4, 400
Silvical investigations	6, 500
Planting	36, 200
Improvements	59, 297
Range investigations	1, 750
State cooperative fire protection	8, 850
Roads and trails for States	22, 978
Federal-aid roads (sec. 8)	2, 000
<b>Total</b>	<b>766, 496</b>

##### District 3, Albuquerque, N. Mex.:

District office and field work	82, 774
National forests—	
Apache	22, 450
Carson	24, 894
Coconino	40, 573
Coronado	31, 858
Crook	14, 925
Datil	37, 350
Gila	27, 547



## District 3, Albuquerque, N. Mex.—Continued.

## National forests—Continued.

Lincoln-----	\$29, 278
Manzano-----	15, 325
Prescott-----	23, 630
Santa Fe-----	41, 540
Sitgreaves-----	23, 979
Tonto-----	24, 109
Tusayan-----	30, 741
Reserve (fire protection, etc.)-----	1, 600
Land classification-----	6, 450
Entry survey-----	9, 380
Timber survey-----	1, 850
Grazing reconnoissance-----	5, 850
Silvical investigations-----	9, 825
Planting-----	8, 616
Improvements-----	59, 181
Range investigations-----	1, 200
Roads and trails for States-----	22, 344
Federal-aid roads (sec. 8)-----	1, 000

Total-----598, 269

## District 4, Ogden, Utah:

## District office and field work-----

84, 540

## National forests—

Ashley-----	12, 940
Boise-----	21, 288
Bridger-----	14, 053
Cache-----	21, 128
Caribou-----	15, 717
Challis-----	12, 727
Dixie-----	8, 584
Fillmore-----	16, 339
Fishlake-----	14, 227
Humboldt-----	22, 185
Idaho-----	19, 710
Kaibab-----	8, 869
La Sal-----	10, 434
Lemhi-----	11, 943
Manti-----	18, 508
Minidoka-----	12, 697
Nevada-----	9, 780
Payette-----	25, 559
Powell-----	9, 560
Salmon-----	20, 099
Sawtooth-----	16, 422
Sevier-----	14, 524
Targhee-----	27, 813
Teton-----	17, 349
Toiyabe-----	10, 573
Uinta-----	17, 662
Wasatch-----	17, 964
Weiser-----	19, 895
Wyoming-----	14, 720

Reserve (fire protection, etc.)-----	4, 228
Land classification-----	2, 392
Entry survey-----	14, 275
Grazing reconnoissance-----	4, 400
Silvical investigations-----	500
Planting-----	16, 400
Improvements-----	57, 703
Range investigations-----	8, 900
State cooperative fire pro- tection-----	27, 700
Roads and trails for States-----	12, 891
Federal-aid roads (sec. 8)-----	1, 200

Total-----673, 398

## District 5, San Francisco, Cal.:

## District office and field work-----

105, 900

## National forests—

Angeles-----	43, 336
California-----	25, 106
Cleveland-----	23, 382
Eldorado-----	17, 043
Inyo-----	11, 157
Klamath-----	28, 271
Lassen-----	25, 229
Modoc-----	17, 691
Mono-----	11, 174
Monterey-----	6, 058
Plumas-----	33, 060

## District 5, San Francisco, Cal.—Continued.

## National forests—Continued.

Santa Barbara-----	\$27, 453
Sequoia-----	34, 955
Shasta-----	31, 778
Sierra-----	29, 654
Stanislaus-----	26, 443
Tahoe-----	33, 033
Trinity-----	30, 784
Reserve (fire protection, etc.)-----	46, 120
Land classification-----	9, 067
Entry survey-----	1, 200
Timber survey-----	6, 505
Grazing reconnoissance-----	6, 550
Silvical investigations-----	1, 400
Planting-----	6, 533
Improvements-----	72, 577
Range investigations-----	1, 150
Roads and trails for States-----	17, 473
Federal-aid roads (sec. 8)-----	2, 100

Total-----732, 182

## District 6, Portland, Oreg.:

## District office and field work-----

104, 480

## National forests—

Cascade-----	20, 496
Chelan-----	14, 257
Chugach-----	16, 445
Columbia-----	19, 919
Colville-----	15, 435
Crater-----	34, 582
Deschutes-----	22, 967
Fremont-----	16, 928
Malheur-----	14, 449
Minam-----	9, 799
Ochoco-----	15, 694
Okanogan-----	21, 170
Olympic-----	25, 660
Oregon-----	36, 075
Rainier-----	24, 752
Santiam-----	12, 796
Siskiyou-----	27, 970
Siuslaw-----	13, 770
Snoqualmie-----	25, 848
Tongass-----	36, 660
Umatilla-----	15, 108
Umpqua-----	19, 265
Wallowa-----	20, 005
Washington-----	13, 285
Wenaha-----	13, 071
Wenatchee-----	22, 603
Whitman-----	33, 287

Reserve (fire protection, etc.)-----	7, 235
Land classification-----	20, 140
Entry survey-----	11, 225
Timber survey-----	13, 000
Grazing reconnoissance-----	5, 600
Silvical investigations-----	4, 900
Planting-----	28, 500
Products investigations-----	3, 800
Improvement-----	91, 159
Range investigations-----	750
State cooperative fire pro- tection-----	16, 600
Roads and trails for States-----	23, 555
Federal-aid roads (sec. 8)-----	2, 800
Land exchange with State of Washington-----	4, 945

Total-----900, 985

## District 7, Washington, D. C.:

## District office and field work-----

20, 719

## National forests—

Alabama-----	2, 725
Arkansas-----	26, 820
Cherokee Georgia-----	9, 119
Florida-----	14, 643
Luquillo-----	3, 515
Monongahela-----	3, 436
Natural Bridge-----	6, 968
Ozark-----	13, 892
Pisgah-----	18, 756
Savannah-----	11, 979

District 7, Washington, D. C.—  
Continued.

## National forests—Continued.

Shenandoah-----	\$13,853
Unaka-----	4,450
White Mountain-----	14,014
White Top-----	5,220
Wichita-----	6,035
Reserve (fire protection, etc.)-----	238
Improvement-----	13,507
Roads and trails for States--	4,365
Federal-aid roads (sec. 8)--	200

Total -----	194,454
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Total, Forest Service (ex- clusive of unallotted contingents)-----	5,904,555
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## Unallotted contingents:

General adminis- tration, etc----	\$35,405
Land classifica- tion-----	21,361
Fire protection---	147,100
Forest products --	1,140
Range investiga- tions-----	1,640
Planting-----	3,100
Timber surveys---	29,035
Grazing reconnois- sance-----	2,800

	\$241,581
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Total, Forest Service--	6,146,136
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## BUREAU OF CHEMISTRY.

### GENERAL ADMINISTRATION.

#### Office of Chief:

*Object.*—General administration of the research, regulatory, and business affairs of the bureau.

*Cooperation.*—Other bureaus of the department.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Assignment.*—C. L. Alsberg, chief; W. G. Campbell, assistant chief.

*Proposed expenditures, 1918-19.*—\$50,340.

#### Office of Chief Clerk:

*Object.*—To supervise the clerical work of the bureau.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Assignment.*—S. A. Postle.

*Proposed expenditures, 1918-19.*—\$6,500.

#### Editorial Work:

*Object.*—To edit and prepare for printing manuscripts and to read and revise proofs of articles submitted for publication by investigators of the bureau; also similar work in connection with all printing required by the bureau.

*Cooperation.*—Division of Publications.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Assignment.*—K. A. Smith.

*Proposed expenditures, 1918-19.*—\$8,240.

#### Library:

*Object.*—To circulate and maintain for reference the books and periodicals of the bureau library and to furnish books and information desired by the workers from libraries in and outside of Washington; to buy and care for books and periodicals bought with bureau funds for the field stations; to translate and index the collection of foreign food and drug legislation and to furnish information in regard to this collection; to translate correspondence, labels, etc.; reference and bibliographical work.

*Cooperation.*—Department library; other libraries in and out of Washington.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Assignment.*—A. E. Draper.

*Proposed expenditures, 1918-19.*—\$5,200.

#### Accounts:

*Object.*—Supervision and maintenance of the financial records of the bureau.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Assignment.*—Accountant to be appointed.

*Proposed expenditures, 1918-19.*—\$13,360.

#### Supplies:

*Object.*—Purchase, receipt, maintenance, and distribution of supplies, and records covering same.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Assignment.*—R. E. Conner.

*Proposed expenditures, 1918-19.*—\$20,390.

**Mail and Files:**

*Object.*—Handling and filing incoming and outgoing mail, and messenger work.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Assignment.*—L. St. L. Standish.

*Proposed expenditures, 1918-19.*—\$18,410.

**Stenographic Work:**

*Object.*—To assist offices and laboratories in general stenographic and clerical work.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Assignment.*—L. F. Shipe.

*Proposed expenditures, 1918-19.*—\$13,880.

**Preparation of Educational Material:**

*Object.*—To handle the educational work of the bureau, prepare material for lectures, demonstrations, and exhibits, and to care for exhibits in Washington and when displayed at various congresses and expositions throughout the country.

*Cooperation.*—Other branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1918.

*Assignment.*—T. F. Pappe.

*Proposed expenditures, 1918-19.*—\$3,000.

**Superintendence of Building:**

*Object.*—To perform the mechanical and cleaning work of the bureau.

*Cooperation.*—Department shops.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Assignment.*—H. F. Marti.

*Proposed expenditures, 1918-19.*—\$26,150.

**Total, General Administration,** \$165,470, including \$126,670 statutory (research, \$55,160; regulation, \$110,310). This total includes \$38,800 from appropriation for enforcement of the food and drugs act.

**[Research.]****INVESTIGATIONS IN AGRICULTURAL CHEMISTRY.****CHEMISTRY OF PLANT GROWTH.****Chemistry of Plant Growth:**

*Object.*—To determine the effect of recognized plant-food constituents and of other inorganic elements applied at different stages, also the effect of light, on the composition and physical characteristics of plants and on the changes in composition which take place during their growing period as a result of any particular treatment.

*Procedure.*—Seedlings are grown in culture solutions and analyzed at different stages, and greenhouse or field crops are treated with different plant foods or subjected to varying conditions of light and shade and the resultant plants analyzed. Field or greenhouse crops are analyzed at different periods of growth after having been subjected to different treatment.

*Cooperation.*—Office of Cereal Investigations, Bureau of Plant Industry, and various State experiment stations.

*Location.*—Washington, D. C., Hays, Kans., University Farm, Minn., and Arlington Farm, Va.

*Date begun.*—1909.

*Results.*—The influence of the calcium-magnesium ratio on root development has shown that the root growth was not affected under the conditions of the bureau's experiments by differences of calcium or of magnesium in the solution culture.

Bureau of Chemistry Bulletin 138, "Translocation of Plant Food and Elaboration of Organic Plant Material in Wheat Seedlings," showed that



chemical changes take place during the first three weeks of the plant's growth, beginning with the seed before germination. The plants were treated with solutions of nitrate, potash, and phosphoric acid. The absorption of these plant foods was noted at different stages of growth. The published results showed the amount of inorganic material absorbed and how the formation of new organic material was brought about.

Bureau of Chemistry Bulletin 149, "The Growth of Wheat Seedlings as Affected by Acid or Alkaline Conditions," showed that a continuous application of ammonium sulphate or potassium sulphate or chlorid renders the soil so acid as to cause the crop to be almost an absolute failure, thus corroborating field experiments made at various experiment stations in this country and in England.

The results further showed that the addition of lime or of iron or aluminum hydrate to culture media containing potassium chlorid, potassium sulphate, or ammonium salts had a tendency to keep these solutions alkaline. This would tend to explain why field applications of sulphate or muriate of potash in time render the soil acid, unless lime is also applied, while the continued use of Chile saltpeter produces an alkaline condition of the soil.

Greenhouse experiments carried on to determine whether starchy grains or flinty grains can be grown at will show that it is quite possible to produce a starchy grain of the so-called yellow berry by keeping the soil saturated with water. The result of this work shows that the starchy grains are not hereditary and that the production of yellow berry type is not due to diseases but primarily to the excess of water available to the growing plant.

The investigation conducted in water culture on the effect of lime on the alkali tolerance of wheat seedlings showed that the presence of lime in small amounts was capable of overcoming the toxicity of alkali salts. In this investigation it was also shown that the benefit which lime exerts is not one of preventing the absorption of the toxic alkali salts by the growing plant but rather one in which the toxicity of the alkali salts seems to be overcome by the presence of the lime.

As a result of the collaborative work with the Bureau of Plant Industry on the study of the causes of the mottle leaf in the citrus regions of California, it appears that this mottle-leaf disease may be due to the presence of a large amount of lime and at the same time to the absence of a sufficient amount of organic material in the soil.

The presence of sodium nitrate in the soil at the early stages of growth stimulated the vegetative growth of the crops and consequently gave greater yields.

Its presence in the soil at the time of heading gave a better quality of grain with reference to color and protein content, although the vegetative growth was not affected in any way. Its presence at the milk stage of the grain had no effect on yield, quality, or protein content.

The use of potassium chlorid did not affect the vegetative growth, nor did it appreciably affect the composition of the grain, but it appeared to increase the amount of yellow berry when used alone.

*Assignment.*—J. A. Le Clerc, J. Davidson.

*Proposed expenditures, 1918-19.*—\$3,420, including \$200 statutory.

#### INFLUENCE OF ENVIRONMENT ON CROPS AND PLANTS.

##### Influence of Environmental Factors on the Composition of Crops:

*Object.*—To determine the rôle played by the kind and quality of seed and the influence of climatic agencies and of the soil on the composition of crops and on their physical characteristics.

*Procedure.*—In the bureau's so-called trilocal experiments a definite sample of seed is grown in each of three localities varying greatly in climatic conditions. From each of the resultant crops seed is then grown in each locality in small plots side by side and the crops analyzed.

In the trilocal soil-exchange experiments small plots of soil are interchanged between each of three localities, and in each of these three lots of soil in each locality the same seed has been sown and the resultant crop analyzed.



In the regular environmental investigations the composition of the same varieties of plants grown at and obtained from different States or localities is determined.

In order to determine more definitely the influence of soil on the composition of crops, it is proposed to transport to some convenient experiment farm, possibly the Arlington Farm, a definite area of soil of each of several kinds—sandy clay, marl, muck, etc.—and to grow the same crops in each soil.

*Cooperation.*—Office of Cereal Investigations, Bureau of Plant Industry.

*Location.*—Washington, D. C., and Maryland, South Dakota, Kansas, Texas, and California experiment stations.

*Date begun.*—1905.

*Results.*—Bureau of Chemistry Bulletin 128 gives the results of three years' work, which has in the meantime been confirmed by the subsequent investigations. Climate plays the predominant part in influencing the composition of grains, and when wheat of the same variety obtained from different sources and possessing widely different chemical and physical characteristics is grown side by side in any one locality, the resultant crops are almost identical in composition and appearance. When wheat of any one variety and from any one source is grown in different localities possessing different climatic conditions, the resultant crops are very different in appearance and in chemical composition. In the bureau's trilocal experiments the crops grown on the three plots at any one locality were identical in appearance and composition, but the crops grown on the three plots of any locality were different from those grown in each of the other two localities.

The results of the first four years' work on the soil-exchange experiments were published in the *Journal of Agricultural Research*, vol. 1, No. 4. Continued work has confirmed these results, which indicate that the soil as such plays a minor part in influencing the composition of wheat. For example, the wheat grown on each of the three soils in Maryland varied from 10 to 13 per cent in protein, while on similar soils transported to Hays, Kans., the wheat contained from 18 to 20 per cent of protein. The wheat grown on each of the three plots in Maryland was identical in appearance, but it was entirely different in appearance from the wheat grown on similar soils in Kansas.

In the regular environmental work the results of the analysis of grains grown under different conditions indicate that the climatic conditions prevailing during the growing season affect the composition of the crop. Data on the subject were published in *Department Yearbook* (1906) article, "The Effect of Climatic Conditions on the Composition of Durum Wheat." It was shown that the durum wheats grown in the semiarid or arid regions contain from 3 to 6 per cent more protein than the same wheats grown in the humid regions.

An article on "The Composition of Grain Sorghums" has been published in the *Journal of the American Society of Agronomy*, vol. 9, 1917. This article gives the results of the analysis of several hundred samples of grain-sorghum kernels grown at Amarillo, Tex., for five successive years. The results show that the composition of the sorghums is very similar to that of the well-known cereals and also that the composition varies from year to year, depending upon the climatic condition. The protein content of these grain sorghums varies from 10.1 to 14.7 per cent.

During years of comparatively heavy rainfall, particularly before the time of emergence, the protein content of the grain sorghums is low, while in years of light rainfall the protein content is high. As a rule, a high protein content is correlated with a low yield per bushel, and vice versa.

*Assignment.*—J. A. Le Clerc, J. Davidson.

*Proposed expenditures, 1918-19.*—\$2,235, including \$145 statutory.

**(Influence of Stacking, Shocking, and Storing Grain:** Discontinued as a separate project; included under "Studies in Bread Making.")

**(Value of Leaves of Different Species for Manurial Purposes:** Discontinued as a separate project; included under "Chemistry of Plant Growth.")

**(Loss of Plant Constituents of Hay Due to Weather Conditions:** Discontinued as a separate project; included under "Chemistry of Plant Growth.")



## STUDIES OF MILL PRODUCTS.

(Wheat, Flour, and Prepared Cereal Products: Transferred to subgroup "Food Investigations," under "Enforcement of the Food and Drugs Act.")

(Keeping Quality of Flour Under Insect-Control Treatment: Discontinued as a separate project; included under "Studies in Bread Making.")

(Studies of the Composition and Utilization of the Soy Bean and Its Products: Transferred to subgroup "Food Investigations," under "Enforcement of the Food and Drugs Act.")

## STUDIES IN BREAD MAKING.

## Studies in Bread Making:

*Object.*—To show how good bread can be made from different flours; to determine the influence on bread making of the various yeasts, malt extracts, or other aids in baking; to determine what substitutes for flour are suitable for bread making and to what extent; to study the effect of different treatments of wheat and flour on the baking quality of the flour.

*Procedure.*—It is proposed to obtain information regarding the methods in vogue for the making of bread from the various flours (as, for example, the use of soft wheat flours to make French bread); to bake bread with the different kinds of yeasts, malt extracts, and other aids in baking, and to use different amounts of these under varying conditions; to subject wheat and flour to different processes or treatments and to determine the effect on the quality of the flour and bread produced therefrom.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—Experiments have been made with about 40 part substitutes for flour in baking bread which can be profitably used in the ratio of 25 parts to 75 parts of flour. The composition of these flour substitutes and the breads made with 25 per cent of these substances has been determined. It has been shown that special breads can be made from certain flour substitutes which may be of great value in localities where these substances are abundantly available. Methods for making bread containing 57 per cent of boiled potato and 43 per cent of good spring-wheat flour have been worked out, the possibility of making a satisfactory loaf of bread with so large a quantity of boiled potato having been fully demonstrated.

A manuscript on "Potato Bread" has been submitted for publication. This gives the composition of bread made with 57 parts boiled potato and 43 parts of bread flour and compares the food value and economic value of potato bread and ordinary bread.

An address giving in a general way some of the results in the use of flour substitutes in baking was delivered before the Potomac States Master Bakers' Association in Washington in 1916 and was published in the Bakers' Weekly of May 27, 1916.

A paper was published in the Journal of Industrial and Engineering Chemistry for November, 1916, entitled "The Determination and Distribution of Moisture in Bread." This article tells how to sample bread accurately in order to determine the amount of moisture in the loaf; how the moisture is distributed in the loaf—that is, from the ends toward the center; and the amount of moisture in the crust and in the crumb.

A series of recipes and general directions for utilizing a number of flour substitutes in baking have been prepared for the States Relations Service for use in the county-agent work in the South.

Farmers' Bulletin 807, "Bread and Bread Making," has been published. This is a collaborative work between the Bureau of Chemistry and the Office of Home Economics of the States Relations Service, and relates to the baking of bread in the home.

An article entitled "The Home Grinding of Wheat," prepared by the States Relations Service and published in the Weekly News Letter, gives a number of recipes for making good loaf bread from home-ground flour.

An article in the Weekly News Letter, entitled "The Use of Corn Meal in Bread Making," contains numerous recipes for the use of corn as a flour substitute.



Farmers' Bulletin 955, "Use of Wheat Flour Substitutes in Baking," is based on work carried on under this project.

Numerous addresses have been given in Washington, D. C., on the general subject of flour substitutes. Addresses on the same subject have been given in New York and Chicago, on the invitation of the Food Administration, and at Ames and Camp Dodge, Iowa, on the invitation of the Iowa Agricultural Experiment Station.

Experiments with flours of different extraction, from 70 to 100 per cent, indicate that very good bread can be made with flour of much higher extraction than is at present made.

Baking experiments with egg substitutes are in progress.

*Assignment.*—J. A. Le Clerk, L. H. Bailey, P. L. Mann.

*Proposed expenditures, 1918-19.*—\$2,530, including \$160 statutory.

**(Study of the Methods of Bread Making with Soft Winter-Wheat Flour:** Discontinued as a separate project; included under "Studies in Bread Making.")

**(Use of Yeast, Malt Extract, and Other Aids in Baking:** Discontinued as a separate project; included under "Studies in Bread Making.")

**(Use of Part Substitutes for Flour in Baking:** Discontinued as a separate project; included under "Studies in Bread Making.")

#### MALTING.

##### Malting:

*Object.*—To investigate the quality of malt obtained from different kinds of barley when malted under different conditions.

*Procedure.*—Samples of different varieties of barleys are analyzed and subsequently malted under varying conditions of temperature and moisture and the resultant malts analyzed, in order that their value for malting or for the production of malt extract may be determined.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Results.*—Bureau of Chemistry Bulletin 124 gives the results of several years' work and includes analyses of barleys from the various States and data on the malt produced therefrom. The malting was conducted under commercial supervision, but most of the analytical work on the barleys and malt was done by this bureau.

*Probable date of completion.*—1920.

*Assignment.*—J. A. Le Clerc, C. D. Garby.

*Proposed expenditures, 1918-19.*—\$505, including \$40 statutory.

#### MISCELLANEOUS ANALYSES OF PLANTS AND PLANT PRODUCTS, FLOURS, ETC.

##### Miscellaneous Analyses:

*Object.*—To determine the composition of plants and plant products submitted for analysis by the Bureau of Plant Industry and by the various laboratories of the Bureau of Chemistry.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Results.*—During 1917 about 1,600 samples of all kinds were received for analysis. These included samples from ten different offices of the Bureau of Plant Industry, as well as from the States Relations Service, and a few from the Food Administration, the Panama Railroad, the United States Marine Corps, and two State experiment stations. More than half of the total number were received from the Office of Forage-Crop Investigations of the Bureau of Plant Industry, consisting of soy beans grown in a score of localities. About 200 samples of wheat, sorghums, barleys, oats, flax, etc., in connection with the trilocal experiments referred to in project "Influence of Environmental Factors on the Composition of Crops" were received from the Office of Cereal Investigations. Almost 100 samples of flours and other mill products, as well as 60 samples of pearl barleys and the offal from the pearling process, were also received.

*Assignment.*—L. H. Bailey, C. D. Garby, P. L. Mann.

*Proposed expenditures, 1918-19.*—\$3,570, including \$865 statutory.



## LEATHER AND TANNING INVESTIGATIONS.

**Investigations of the Wearing Quality of Sole Leather and Sole-Leather Substitutes:**

*Object.*—To determine the effect on quality of leather of various tanning processes, the relative value of leather made from different sections of the hide and from different kinds of hides, the effect of methods of curing hides on the quality and characteristics of leather, and the value of sole-leather substitutes.

*Procedure.*—The wearing quality of sole leather obtained by various processes of tanning and representing various cures, classes, and sections of hides is being studied and the comparative value of sole-leather substitutes determined and correlated with the results of chemical analyses.

*Cooperation.*—Tanners and shoe manufacturers as found advisable.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: A testing machine was designed and built and certain necessary attachments satisfactorily proved. Wearing and analytical data have been obtained. Work on the standardization of the machine has continued. A constant sand feed has been originated, built, and proved to be successful. A volumenometer for measuring the volume of samples before and after wearing has been devised. Numerous tests of sole leather and sole-leather substitutes have been made and differences to resistance to wear noted.

(2) During 1918: Additional tests were made on sole leather and sole-leather substitutes, the results of which, including a detailed description of the machine, have been published. Articles describing the constant sand feed and the volumenometer have been published in the *Journal of the American Leather Chemists' Association* and the *Journal of Industrial and Engineering Chemistry*, respectively. A new machine, which will eliminate certain objectional features of the old one, has been designed and is being built. The necessary arrangements have been made to cooperate with the War Department in extensive experiments on the wearing quality of leathers and leather substitutes for shoes.

*Assignment.*—R. W. Frey, I. D. Clarke.

*Proposed expenditures, 1918-19.*—\$2,200.

(See also Supplement—Emergency Activities, p. 578.)

**Disposal of Tannery and Leather Wastes:**

*Object.*—To utilize profitably tannery and leather wastes, distribute information on the agricultural value of these wastes, and prevent the pollution of drainage waters by such wastes.

*Procedure.*—Data on tannery-waste disposal and treatment are compiled from various sources. The experience of those who have installed plants is sought, with full data as to efficiency, in order to make the matter of general value. Effective installations are inspected and information as to cost and other pertinent matters collected. Analyses of recovered products are made to determine their agricultural and industrial value. Suggestions and advice are supplied on the subject.

*Cooperation.*—American Leather Chemists' Association, National Association of Tanners, and Hygienic Laboratory, Treasury Department.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: Information has been compiled showing that it is feasible to purify tannery waste liquors by well-established and simple processes and that the waste thus recovered may be disposed of for agricultural purposes, sometimes at a profit. Analyses of a number of wastes and recovered products have been made. Articles covering recent information on tannery wastes have been published in the *Journal of the American Leather Chemists' Association*. Data have been compiled on the agricultural value of waste, and information has been furnished the tanning industry through correspondence.

(2) During 1918: No research work was conducted on this project during 1918. Information and assistance has been furnished to the industry through correspondence. The industry is now giving serious consideration to the purification and utilization of effluents, and a number of plants are being installed. The procedures for the purification of efflu-



ents advocated by the Bureau of Chemistry in several publications are being applied successfully on a commercial scale and new processes are under observation.

*Assignment.*—F. P. Veitch.

*Proposed expenditures, 1918-19.*—\$1,750.

### **Investigations of the Composition and Properties of Leather and of Tanning and Finishing Materials:**

*Object.*—To furnish the public useful information relative to the purchase of leather and leather articles, secure helpful information on the composition of these materials, show the relation between the composition and quality of the materials, and improve existing methods of examination and devise new methods where needed.

*Procedure.*—The materials are examined by chemical, physical, and microscopical methods for normal, abnormal, and harmful constituents, and the effect of the presence of such constituents is noted. Old methods of testing are critically examined and improved or new ones substituted when needed. The work is essential as a foundation for advanced practical work.

*Cooperation.*—Association of Official Agricultural Chemists, American Leather Chemists' Association, and International Association of Leather Trades Chemists.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Results.*—(1) Prior to 1918: Assistance has been given to the study and improvement of methods of examining leathers, tanning materials, oils, and greases, and tanning products in general. The results obtained have been published for the information of chemists from time to time in the Journal of the American Leather Chemists' Association, and Bureau of Chemistry Bulletin 165 on the composition of American sole leather has been issued.

A quick and exact method for the determination of reducing sugars in leather has been completed and published. Methods for the determination of mineral acids in leather have been studied. Preliminary work has been done on the identification of tanning materials in mixtures. A test for the detection of chestnut and white oaks has been improved and the results published in the Journal of American Leather Chemists' Association.

Cheaper filter paper than that now used has been sought for use in tannin determination, with negative results. Methods for the detection of sulphite cellulose liquors in tanning materials have been tested, with unsatisfactory results. Domestic sumacs were investigated relative to production and tannin content.

Cooperative work was conducted on methods of analysis for tanning materials and leathers, the determination of acidity in leathers, and the effect of hard water in the extraction and solution of tanning materials. Analyses of leathers, barks, and other tanning and finishing materials have been made for research purposes and for other Federal departments.

(2) During 1918: Department Bulletin 706, "American Sumac—A Valuable Tanning Material and Dyestuff," has been published. Directions given in this bulletin for the proper gathering and curing of sumac should result in an increased output and an improved product. Cooperative work on the analysis of tanning materials and leather has been continued. Numerous samples of tanning and other materials have been analyzed for their tannin content.

A great deal of work has been done for the War Department on bag, strap, harness, upper, and sole leather; in determining the suitability of certain leathers for special purposes; in the physical examination of leathers; and in testing the efficacy of various finishing materials and treatments. Assistance has also been given the War Department in the preparation of specifications for leathers. Information has been given the public, through correspondence, on tanning and related subjects.

*Assignment.*—R. W. Frey, I. D. Clarke.

*Proposed expenditures, 1918-19.*—\$2,200.



**Deterioration of Upper, Bookbinding, and Other Light Leathers:**

*Object.*—To discover the causes and to prevent the deterioration of light leathers, to eliminate the use of harmful materials in leather making, and to conserve raw materials by making better leather.

*Procedure.*—Badly deteriorated as well as durable leathers are carefully examined to determine wherein they differ in composition, appearance, and physical condition, for the purpose of explaining the serviceability of the leathers. Cooperation has been established with a number of public libraries to compare the durability of binding leathers in service with the determined composition of the leathers.

*Cooperation.*—War Department, American Library Association, individual libraries, bookbinders, and tanners.

*Location.*—Washington, D. C.; libraries in New York City, Providence, R. I., and Newark, N. J.

*Date begun.*—1912.

*Results.*—(1) Prior to 1918: The harmful effects of large quantities of sulphuric acid have been definitely shown. Specifications have been suggested for durable leathers, especially for Government and library purposes. Old deteriorated bindings and leathers for new bindings have been examined and the data preserved for future reference. Cooperative experiments with several public libraries on the durability of bookbinding leathers have been inaugurated. Analyses have been made, data collected, and work to devise an accurate method for determining free acids continued.

(2) During 1918: Extensive experiments on the effect of oils, greases, waxes, and various treatments on upper leathers have been undertaken, primarily for war purposes, though the information will be of the utmost service both to the tanner and the user of leather.

*Assignment.*—R. W. Frey, I. D. Clarke.

*Proposed expenditures, 1918-19.*—\$500.

**Tanning Leather on a Small Scale:**

*Object.*—To ascertain tanning methods which may be successfully and economically used by farmers and tradesmen in the tanning of leathers on a small scale.

*Procedure.*—Small-scale tannings are actually made with the simplest equipment, such as may be available on the farm. The procedures, equipment, and results will be disseminated through publications and otherwise.

*Cooperation.*—Small tanners.

*Location.*—Washington, D. C.

*Date begun.*—1916.

*Results.*—(1) Prior to 1918: Necessary apparatus was installed, and experiments on the tanning of sole leather with commercial extracts and with homemade bark extract and on the tanning of furs were conducted.

(2) During 1918: An illustrated publication showing the various steps in home tanning is being prepared.

*Assignment.*—F. P. Veitch.

*Proposed expenditures, 1918-19.*—\$1,750.

**Curing and Tanning of Skins as Affected by Biological Processes:**

*Object.*—To control and develop the biological factors involved in or incidentally present in tanning processes and in the deterioration of leather and vegetable tanning materials, with a view to so preserve the skin as to insure high-quality leathers, conserve tanning materials, and reduce the cost of production.

*Procedure.*—The various operations of leather manufacture will be studied in the laboratory and in tanneries with particular attention to biological factors. The effects of these factors will be determined and procedures for their development or restriction devised. The deterioration of leather and tanning materials resulting from biological causes will be studied and methods developed for preventing such deterioration.

*Cooperation.*—Selected tanneries and Federal departments.

*Location.*—Headquarters, Washington, D. C.

*Date begun.*—1918.

*Assignment.*—F. P. Veitch, B. S. Levine.

*Proposed expenditures, 1918-19.*—\$750.



**Total, Leather and Tanning Investigations, \$9,150, including \$540 statutory.**

**PAPER INVESTIGATIONS.**

**Paper Investigations- (General):**

*Object.*—To demonstrate the more rational and economical use of paper, in order to conserve paper-making materials; to effect economies in and to aid in the intelligent manufacture of paper; to determine the factors which control the serviceability, suitability, and durability of papers; to improve the quality of papers; to aid in furnishing a basis for the intelligent interpretation of the characteristics of paper; and to improve methods and conditions for obtaining more accurate, uniform, and useful results.

*Procedure.*—Laboratory methods for serviceability, suitability, and durability are being developed and correlated with actual experience. The factors which determine the uses of paper are carefully studied. From the data thus obtained, improvements in processes of paper making will be devised with a view to insure paper better suited for specific uses; the more economical and conservative use of paper-making materials will be promoted; and more rational and definite specifications for papers for various purposes can be prepared.

*Cooperation.*—Government departments, libraries, and selected paper makers.

*Location.*—Headquarters, Washington, D. C.; brief field work at libraries and paper mills as occasion arises.

*Date begun.*—1904.

*Results.*—(1) Prior to 1918: Eight publications have been issued, covering methods and apparatus used in testing. Specifications have been prepared and general information obtained on serviceability, suitability, durability, and economical use, and also on the conservation of raw materials. The general form and substance of the specifications developed in the laboratory have been adopted by the chief Federal purchasing agents as well as by scientific societies and by State governments and corporations. Existing methods and apparatus and conditions for paper testing have been investigated and their value, effects, and results determined. Methods, apparatus, and conditions of testing have been markedly improved. Many somewhat intangible results have followed, including more intelligent and fairer competition in bidding on Government supplies, the more regular delivery of specified material, the use of paper better suited for the purpose in hand, and the more economical and conservative purchase of paper. Savings of many thousands of dollars in the purchases of the Government Printing Office and the Post Office Department and other departments have resulted from the use of more suitable lighter papers, based on the tests made by the Bureau of Chemistry and the recommendations constantly urged in its publications and in its advisory capacity.

In response to the urgent need of the Government and the public, resulting from the shortage and high prices of blueprint chemicals, an economical method of preparing potassium-ferricyanide solution has been developed and published. Large coaters of blue and brown print papers have followed the suggestions made by the bureau that they prepare their own potassium-ferricyanide for blue and brown print coating and are now making practically all their chemicals at a very large saving. Investigations on blueprint paper have been of service in establishing more solidly the manufacture of such paper in this country and enabling the Government and engineers generally to procure in this country high-grade blueprint paper.

(2) During 1918: Five publications were issued as follows: "The Standardization and Accuracy of the Tester for Determining the Folding Endurance of Paper," "A Constant Temperature and Humidity Room for the Testing of Paper, Textiles, Etc.," "A Method for Determining the Absorbency of Paper," "Blue and Brown Print Papers: Characteristics, Tests, and Specifications," and "A New Instrument for Measuring the Translucency of Paper." A large number of tests on blue and brown print papers have been made for the Navy Department, and specifications covering their purchase have been drawn.



As a result of the work conducted on the absorption of blotting paper and practical service tests made in the various departments, it was suggested to the General Supply Committee, the Post Office Department, and the Government Printing Office that by using a much lighter-weight blotting paper for blotting purposes the same service could be secured at a saving of from 40 to 60 per cent in cost compared with the paper being used generally by the Government. This suggestion was adopted by the Government departments mentioned.

At the request of the Bureau of Mines assistance was rendered on the manufacture of gas masks by aiding in securing a satisfactory absorbent. Cooperative work was conducted with the Bureau of Engraving and Printing on the effects of humidity on distinctive paper and the processes of engraving, sizing, and finishing. Aid was given the Post Office Department in revising specifications for papers.

*Assignment.*—F. P. Veitch, E. O. Reed.

*Proposed expenditures, 1918-19.*—\$1,700.

### **Fiber-Board Investigations:**

*Object.*—To investigate the problems of specifying, devising methods of testing, making water-resistant, and producing suitable and properly constructed board and paper containers that will resist both domestic and overseas transportation service. Paper products, fiber board, wall board, and water-resistant paper wrappings are rapidly replacing wood and even tin for certain kinds of food and merchandise containers. There are no methods for testing or specifications for insuring the manufacture of a satisfactory box board that will withstand the forces of destruction met with in transportation, especially in overseas shipments. Neither is there any satisfactory method for determining the strength of fiber board, wall board, corrugated board, or water-resistant baling papers.

*Procedure.*—Data are being collected, through service tests and otherwise, to determine the serviceability in transportation of known materials. Methods will be devised to test the containers and the material entering into fiber board used in the manufacture of the containers and wrappings and specifications drawn to insure proper material for serviceable boards, wrappings, and containers.

*Cooperation.*—War and Navy Departments, Food Administration, Forest Service, and the War Service Board of the Fiber Board Industries.

*Location.*—Washington, D. C., Madison, Wis., and mills manufacturing solid and corrugated fiber board and waterproof wrapping papers.

*Date begun.*—1918.

*Probable date of completion.*—1920.

*Results.*—At the request of the Navy Department, specifications were drawn for fiber shipping containers for canned goods based on service tests. As a result of this work a special reinforced type of fiber container for overseas shipment which is unaffected in strength by exposure to excessive moisture was developed. Work on a new water-resistant adhesive as a substitute for silicate of soda has been conducted and a promising material developed. Plans are under way to make a commercial test under mill conditions. At the request of the Quartermaster General's Office of the War Department, tests have been made upon various water-resistant wrapping materials for bales of supplies being shipped overseas. Further service tests in cooperation with the War Department are now under way. An impact tester for testing heavy boards, wall board, solid and corrugated fiber board, etc., has been designed and constructed.

*Assignment.*—F. P. Veitch, E. O. Reed.

*Proposed expenditures, 1918-19.*—\$1,000.

**Total, Paper Investigations, \$2,700, including \$130 statutory.**

### **INVESTIGATIONS OF WOODS AND WOOD PRODUCTS.**

**(Investigations of Woods and Wood Products:** Project completed. Two publications have been issued giving much general information on the principles, equipment, costs, processes, products, and profits of wood distillation. Field experiments on a commercial-unit size have been conducted on resinous wood, resulting in shortening the time of distillations, thereby decreasing the cost of equipment and increasing production to the same



extent. Many data on yields of product have been collected. Examination of products to determine exact yields and to acquire information on the progress and nature of reactions in distillations have been made. Values of products not heretofore recovered have been determined. Complete results will be published later.)

#### INVESTIGATIONS OF ROSIN AND TURPENTINE.

(Improvement of the Quality of Rosin and Turpentine: Discontinued as a separate project; included under "Demonstration of Improved Methods or Processes of Preparing Naval Stores.")

##### Investigations of Wood Turpentine:

*Object.*—To investigate the composition of wood turpentine produced by various processes, to suggest means for improving the quality of wood turpentine, and to publish information on the value of wood turpentine as a paint and varnish thinner.

*Procedure.*—Methods are developed on a laboratory scale for the satisfactory refining of wood turpentine. These methods are tried on an industrial scale and brought to the attention of the wood-turpentine producers through publications. The experiences of paint and varnish makers and of painters are ascertained, and painting and varnishing experiments are made with wood turpentine.

*Cooperation.*—Wood distillers and paint and varnish makers.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Results.*—(1) Prior to 1918: Investigations on the production, refining, and use of wood turpentine as a paint and varnish thinner have been made and results published. Improvements which increase the yield and give a product of better quality have been made in the refining of wood turpentine.

(2) During 1918: A paper describing a satisfactory method of refining wood turpentine has been prepared for publication. Additional information on the use of wood turpentine as a paint and varnish thinner has been obtained and prepared for inclusion in a reprint of a previous publication. Loss in personnel and demands placed on the time of the laboratory force by special war work made extensive work on this project impossible.

*Probable date of completion.*—1920.

*Assignment.*—F. P. Veitch, V. E. Grotlisch.

*Proposed expenditures, 1918-19.*—\$250.

##### Methods of Analysis of Turpentine, Rosin, and Wood Products:

*Object.*—To devise accurate methods for determining the constituents in these articles, to serve as a basis for research work in production and for the preparation of specifications.

*Procedure.*—Many methods now used are erroneous. Accurate methods must be secured. These are being devised by very careful trials on samples of known composition.

*Cooperation.*—American Society for Testing Materials.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Results.*—(1) Prior to 1918: Marked improvements have been made in methods for the examination of turpentine, pine oils, and certain wood distillation products. Results have been issued in four publications. Work has been conducted on the standardization of methods for determining acetic acid, methyl alcohol, and acetone in wood distillates; on differentiating wood turpentine from gum spirits; and on the measurement of color in turpentines and rosin.

(2) During 1918: The methods for determining acetic acid, methyl alcohol, and acetone in wood distillates have been prepared for publication. Information on methods of analysis of rosin, together with the results of the examination of samples, have been furnished to the War Department, and considerable information along this line has been given to State inspectors of naval stores in the South.

*Assignment.*—V. E. Grotlisch.

*Proposed expenditures 1918-19.*—\$350.



**Production of Rosin Oil from Resinous Wood:**

*Object.*—To devise methods for the refining and utilization of the heavy oils from resinous-wood distillation.

*Procedure.*—Methods for refining will be worked out in the laboratory and demonstrated at working plants.

*Cooperation.*—Wood distillers and rosin-oil users.

*Location.*—Washington, D. C.

*Date begun.*—Cursorily, 1901; actively, 1914.

*Results.*—(1) Prior to 1918: Laboratory work gave warrant for the belief that useful rosin oils could be prepared from the heavy oils produced by the destructive distillation of resinous wood. Oils have been produced which are similar in many properties to rosin oils. The properties of these oils have been investigated, and they have been shown to be of commercial value in the flotation concentration of ores.

(2) During 1918: Little was done on this project during 1918 on account of losses in personnel and the demands placed on the time of the laboratory force by war work.

*Assignment.*—F. P. Veitch.

*Proposed expenditures 1918-19.*—\$500.

**Total, Investigations of Rosin and Turpentine, \$1,000, including \$100 statutory.**

**WATERPROOFING, MILDEWPROOFING, AND FIREPROOFING FABRICS.****Waterproofing, Mildewproofing, and Fireproofing Fabrics for Farm and Other Uses:**

*Object.*—To give farmers and others effective and cheap methods of waterproofing, mildewproofing, and fireproofing fabrics for wagon covers, stack covers, tents, tarpaulins, and for other uses.

*Procedure.*—Present methods of waterproofing and mildewproofing will be investigated to determine whether they are effective and economical and whether they can be used safely and satisfactorily on the farm. If so, simple equipment and methods will be described so that farmers may carry out these processes satisfactorily. If there are no satisfactory and cheap methods of waterproofing and mildewproofing, an attempt will be made to devise methods, selected processes being submitted to actual use before final conclusion as to the value of the processes is reached. This will involve small-scale experimental work, both at headquarters and possibly in cooperation with the manufacturers of waterproof and mildewproof fabrics and with one or more of the Government departments. Samples of waterproof and mildewproof fabrics with which Government departments and other users have experimented will be carefully examined in the laboratory, not only for their waterproof and mildewproof properties but to determine the nature of the materials used in waterproofing and mildewproofing.

*Cooperation.*—Manufacturers of waterproofed and mildewproofed fabrics; and Government departments.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: Commercial samples were collected and general information gathered from manufacturers of and dealers in waterproofed and mildewproofed fabrics. Proposed methods of waterproofing and mildewproofing were compiled and their practical value considered. Samples of deteriorated and mildewed fabrics from various sources were examined, and the organisms which produced discoloration and weakening of fabrics were isolated. Methods were devised for the study of mildew and water resistance of fabrics, and the relative effectiveness of various commercial processes for mildewproofing and waterproofing was investigated. Simple and inexpensive methods which are applicable to farm use have been developed for both waterproofing and mildewproofing in one operation.

(2) During 1918: The tests for water and mildew resistance have been further developed and standardized. New and improved formulas for proofing fabrics against water and mildew in one operation have been devised. Commercial treatments have been chemically analyzed and certain general conclusions drawn from the results obtained. The physiological effect on various molds of various metallic soaps alone and



in combination has been studied, with a view to adopt the application of the soaps as proofing agents for fabrics. Much time has been devoted to testing the water-resistant and mildew-resistant values of commercially treated cotton fabrics submitted by the War Department. Assistance has been given the War Department in securing the fabrics suitable for its purposes and to finishers in improving and standardizing their processes.

*Assignment.*—H. P. Holman, B. S. Levine, T. D. Jarrell.

*Proposed expenditures, 1918-19.*—\$4,430, including \$430 statutory.

(See also Supplement—Emergency Activities, p. 578.)

#### CARBOHYDRATE INVESTIGATIONS.

(Investigations in the Manufacture of Sorghum Sirup: Continued as a special subgroup following the project "Utilization of Soy Beans as Human Food.")

(Investigations in Cane-Sugar, Sirup, and Molasses Manufacture: Discontinued as an activity under this group; transferred to the special group "Table Sirup Investigations.")

(Investigation of the Composition of Vinegar Made from Cane and Sorghum Juices and of the Practicability of Making Such Vinegar on a Commercial Scale: Project completed. During the fiscal year 1916 the preliminary work of making several barrels of vinegar from cane juice by the slow-barrel process was done at Cairo, Ga. The vinegar stock prepared was left in a warehouse at Cairo under conditions for the formation of vinegar in due time. Samples of the vinegar have been analyzed, and a report of the work will be prepared.)

#### INSECTICIDE AND FUNGICIDE INVESTIGATIONS.

(Work under this subgroup transferred to the separate main group, "Insecticide and Fungicide Investigations.")

#### FRUIT AND VEGETABLE UTILIZATION INVESTIGATIONS.

##### Potato Drying for Stock Feed:

*Object.*—To prepare a high-grade stock feed from potatoes.

*Procedure.*—Potatoes are washed, ground, and pressed and the residue dried for stock feed. The by-product of this process is potato juice.

*Cooperation.*—Office of Pomological and Horticultural Investigations, Bureau of Plant Industry, and Bureau of Animal Industry.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1914.

*Results.*—Dried pressed potato was found to be easily made at low manufacturing cost. Extensive experimental tests were made by the Bureau of Animal Industry in feeding dairy cows and swine. The product was found to be of the high feeding quality indicated by its analysis. In feeding, it is necessary to balance it by the addition of suitable concentrates. This process has received industrial development at Traverse City, Mich., where from 600 to 1,000 bushels of potatoes a day are being manufactured into dried pressed potato, which is then ground into a flour.

*Assignment.*—H. C. Gore.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

##### Manufacture and Utilization of Potato Starch:

*Object.*—To improve present methods of preparing potato starch in the United States and to increase its use in the arts and as a food.

*Procedure.*—Efforts will be made to develop equipment that can be utilized in the farm home for making potato starch and to devise special improved machinery for the manufacture of potato starch on an industrial scale.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Washington, D. C., and a point in the field to be determined.

*Date begun.*—1916.



*Results.*—Results of laboratory and field work show that potato starch of excellent quality can be made with simple equipment on a small scale. It is necessary to develop an adequate machine for washing and grinding the potatoes and washing and drying the starch. On the industrial scale, a method is in sight whereby, through the use of modern machinery for washing, dewatering, and drying the starch, the process can be made continuous, requires practically no labor, and at the same time does not materially increase the investment.

*Probable date of completion.*—1919.

*Assignment.*—H. C. Gore; assistant to be appointed.

*Proposed expenditures, 1918-19.*—\$2,804.

**(Potato Analyses:** Project completed. The object of this work was to determine the composition of potato samples submitted by the Bureau of Plant Industry. The work was started in 1914, and several hundred analyses have been made.)

#### **Preparation of Ensilage from Potatoes:**

*Object.*—To develop an economical and practical method of preparing a cattle feed from waste potatoes.

*Procedure.*—Potatoes are soured by mixing them with from 2 to 4 per cent cornmeal and then packing in silos. They are later fed to farm animals, especially cattle and swine.

*Cooperation.*—Bureau of Animal Industry.

*Location.*—Washington, D. C., and Beltsville, Md.

*Date begun.*—1915.

*Results.*—A new method of conserving potatoes has been thoroughly demonstrated. The product can be fed successfully to farm animals, especially dairy cattle and swine. In feeding to swine the feed should be balanced by the use of proper concentrates, and in feeding to dairy cattle it should be balanced by the use of roughage and concentrates.

*Probable date of completion.*—1919.

*Assignment.*—H. C. Gore.

*Proposed expenditures, 1918-19.*—\$100.

**(Preparation of Cider Concentrated by Freezing:** Project completed. The department will cooperate with manufacturers and others, however, by furnishing advice. It has been shown that cider can be concentrated by freezing at a reasonable cost. The finished product is sufficiently stable to endure transportation to market without the use of preservatives.)

**(Composition of Grape Juice:** Project completed and results reported to the Bureau of Plant Industry. An article on the subject was also published in the Journal of Industrial and Engineering Chemistry, April, 1916.)

#### **Determination of Food Value of Fruit and Vegetable Products:**

*Object.*—To determine the merits as food of fruit and vegetable products.

*Procedure.*—The basic principles guiding the use of dried vegetables will be investigated and recipes prepared.

*Cooperation.*—Office of Home Economics, States Relations Service.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—The culinary quality and food use of fruit and vegetable products have been studied and various dried fruits and produce examined. No definite results have as yet been obtained.

*Assignment.*—H. C. Gore; assistant to be designated.

*Proposed expenditures, 1918-19.*—\$100.

**(Preparation of Sirup from Sugar Beets:** Project completed. A sirup of excellent quality for cooking and table purposes was found to be prepared easily from sugar beets. It was found impracticable to improve the color and flavor of the product materially without at the same time making the method so difficult that the sirup could not be easily prepared on the farm. The method of preparing the sirup is described in Farmers' Bulletin 823, "Sugar-Beet Sirup.")

#### **Drying of Vegetables and Fruits:**

*Object.*—To assist in the development of the industrial drying of vegetables and fruits.



*Procedure.*—Complete and exhaustive investigations will be carried out in cooperation with commercial concerns at their plants. This commercial line of investigations will be supplemented by research work in the laboratory.

*Cooperation.*—Bureau of Plant Industry, States Relations Service, and Bureau of Public Roads.

*Location.*—Washington, D. C., and field points to be determined.

*Date begun.*—1918.

*Results.*—Previous work has shown the importance of investigations in the drying of fruits and vegetables in order that this new industry may be developed and standardized at the earliest moment. The drying of vegetables is practically a new industry. During the past year as a result of laboratory and field work valuable information has been obtained on the technical problems involved in the drying of vegetables and in keeping such products after drying. This work should now be industrialized. This can best be accomplished by the development of complete type plants in which the drying should be done and by training men for superintending the operation of such plants. This work can be successfully done at plants already engaged in the preparation of food products. Trial of several dryer types should be made to determine the type best adapted for handling the different products in sufficient volume. Three general types of dehydrators are being studied: (1) The tray dryer, (2) the apron dryer, and (3) the vacuum, with auxiliary machinery suitable for tomatoes, fruit juices, certain fruit pulps, and other products, as, for example, malted products capable of being evaporated in liquid form. The manufacture of flour from potatoes, sweet potatoes, and cassava is also being studied.

*Assignment.*—Investigators to be designated.

*Proposed expenditures, 1918-19.*—\$11,216.

**Total, Fruit and Vegetable Utilization Investigations, \$14,220, including \$2,220 statutory.**

(See also Supplement—Emergency Activities, p. 566.)

#### CATTLE-FOOD AND GRAIN INVESTIGATIONS.

##### Composition and Value of Range Forage Crops:

*Object.*—To determine by analytical methods the composition and value of the forage crops growing naturally on the ranges of the arid and semi-arid West.

*Procedure.*—Promising forage plants on the ranges of the arid and semiarid West are collected by agents of the Bureau of Plant Industry and sent to Washington for analysis. The history and description of such samples are written by the Bureau of Plant Industry agent, and the combined results of the two bureaus, together with the average analysis of the same forage crops gathered by the Bureau of Chemistry, are published.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—The results of previous work are published in Department Bulletin 201, "Native Pasture Grasses of the United States." During the fiscal year 1918 a bulletin entitled "The Salt Bushes and Their Allies as Range Forage Plants" was prepared for publication. Two other bulletins on this subject are in course of preparation.

*Assignment.*—J. K. Haywood, G. L. Bidwell, J. B. Reed.

*Proposed expenditures, 1918-19.*—\$310.

##### Utilization of Waste By-Products as Cattle Foods:

*Object.*—To utilize as cattle foods various materials which are now waste products.

*Procedure.*—Factories are visited, the waste products studied chemically, and promising waste materials tested on cattle. Methods of preparing these products in a form suitable for use are also studied.

*Cooperation.*—Various manufacturers.

*Location.*—Washington, D. C.

*Date begun.*—1913.



*Results.*—A number of manufacturing plants have been visited to obtain information in regard to problems to be solved. During 1918 special attention was given to by-products of the olive-oil, brewing, canning, and almond industries. These by-products will be further studied during the present year.

*Assignment.*—J. K. Haywood, G. L. Bidwell.

*Proposed expenditures, 1918-19.*—\$365.

#### **Analysis of Cattle Foods and Grains:**

*Object.*—To aid other bureaus of the department in solving problems in which the composition of cattle foods and grains is a factor.

*Procedure.*—Other bureaus carrying on cattle-food and grain investigations submit samples to the Bureau of Chemistry for examination.

*Cooperation.*—Bureau of Plant Industry and other bureaus of the department.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Results.*—Prior to the fiscal year 1918 between 200 and 300 samples have been examined annually. During the past year about 400 samples were examined.

*Assignment.*—G. L. Bidwell.

*Proposed expenditures, 1918-19.*—\$725.

**Total, Cattle-Food and Grain Investigations, \$1,400, including \$400 statutory.**

#### **ISOLATION AND STUDY OF COMPOUNDS FROM THE COTTON PLANT AND OTHER GOSSYPIUM SPECIES.**

##### **Isolation and Study of Compounds from the Cotton Plant and Other Gossypium Species.**

*Object.*—To study the chemotropism of the cotton boll weevil.

*Procedure.*—Various compounds are isolated from the cotton plant. These are used by the Bureau of Entomology to study the chemotropism of the boll weevil. If it is found that the weevil is attracted to the cotton plant by some definite compound, this knowledge will be used in fighting the pest. Work will be done on the cotton plant, and, if results warrant, will be continued from year to year.

*Cooperation.*—Bureau of Entomology.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—It has been found that an ethereal oil, previously isolated from flowering and fruiting plants of the Upland cotton, *Gossypium hirsutum*, is now also obtained from young plants, mainly seedlings. The amount of oil found is quite small, averaging about 0.0015 per cent. This oil, like the one previously isolated, has proved decidedly attractive to the boll weevil and has been fractionated for further studies. The volatile oil was located in glands which are of lysigenous character and occur quite generally in the different parts of the plant. In addition to this oil, the glands were found to contain gossypol, if unexposed to light, and quercitrin and probably quercimeritrin, if exposed to light. Both quercimeritrin and isoquercitrin were found in the petals. Gossypetrin and gossypetin, isolated from other types of cotton, however, were not observed in the chemical studies of the Upland cotton plant.

Two papers, entitled "On the Chemistry of the Cotton Plant, with Special Reference to Upland Cotton, *Gossypium hirsutum*," and "Chemistry and Histology of the Glands of the Cotton Plant, with Notes on the Occurrence of Similar Glands in Related Plants," discussing these findings in detail, appeared in the Journal of Agricultural Research, vol. 13, No. 8.

*Assignment.*—A. Viehovever, C. O. Johns.

*Proposed expenditures, 1918-19.*—\$725.

#### **UTILIZATION OF SOY BEANS AS HUMAN FOOD.**

##### **Utilization of Soy Beans as Human Food:**

*Object.*—To investigate the uses and manufacture of soy-bean products in China and Japan with the view of extending the use of this valuable food product in the United States.

*Procedure.*—An expert in nutrition has made a study of the soy bean and its products in China. Experiments will be conducted to prepare soy-bean products and adapt them to the use of the people of the United States.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—New York, N. Y.

*Date begun.*—1917.

*Assignment.*—C. O. Johns, Yamei Kin.

*Proposed expenditures, 1918-19.*—\$500.

#### INVESTIGATIONS IN THE MANUFACTURE OF SORGHUM SIRUP.

##### Investigations in the Manufacture of Sorghum Sirup:

*Object.*—To improve the methods of manufacturing sorghum sirup so as to obtain a clearer and brighter sirup which will keep indefinitely without fermenting or crystallizing.

*Procedure.*—Experiments will be carried out in Washington and in the field, at first on a small scale. If these give promise of good results the method will be applied on a scale comparable with that practiced by the average farmer.

*Cooperation.*—Farmers and manufacturers in sorghum-producing regions, and Office of Sugar-Plant Investigations, Bureau of Plant Industry.

*Location.*—Washington, D. C., and various points in the field.

*Date begun.*—1918.

*Assignment.*—C. S. Hudson, J. K. Dale, S. F. Sherwood.

*Proposed expenditures, 1918-19.*—\$1,145.

**Total, Investigations in Agricultural Chemistry, \$47,630, including \$5,230 statutory.**

#### COLLABORATION WITH OTHER DEPARTMENTS.

[Regulation.]

##### Examinations for Post Office Department:

*Object.*—To conduct such investigations and make such analyses of drugs, cosmetics, depilatories, "fat producers," "fat reducers," food suspected of containing poisons, and other material transmitted through the United States mails as the Post Office Department may request, with a view to prevent the use of the mails for fraudulent and harmful purposes; to make analyses of products for other departments, when requested to do so; to advise what constitutes false and fraudulent claims, representations, and promises, medicinal and otherwise; to assist inspectors in preparing evidence so as to make it effective when the cases are called for a hearing; to assist in preparing cases for hearings in conjunction with the procedure covering the issuing of fraud orders and appearing as witnesses in such cases; to advise with and assist the post-office inspectors and Federal district attorneys in planning their cases.

*Procedure.*—The Post Office or other department, upon complaint or otherwise, makes an investigation of a product or business dealing in products or schemes of the above character, alleged to be marketed or conducted in violation of the law, and submits the samples and findings for examination and review. The samples are examined by such methods as are available or as may be developed as the investigation progresses. The results obtained are reported, together with an opinion, when asked for, as to the truth or falsity of the claims, representations, etc., made for the commodity. Products or commodities suspected of containing poisons or deleterious substances are subjected to the methods of analysis indicated in such cases.

There are no standards. Each case represents an individual problem which must be worked out, and the laws that govern it must be taken into consideration. One may be poisoned candy or other product sent through the mails, another involving unfair trade competition, a third exploiting an alleged consumption cure, a fourth a fraudulent hair grower, a fifth a scheme to sell an adulterated article, etc.

*Cooperation.*—Post Office Department.

*Location.*—Washington, D. C.

*Date begun.*—1904.



*Results.*—As a result of the investigations made and reported, the Post Office Department has withdrawn the privileges of the mails from many medicinal products and schemes involving false and fraudulent claims, representations, and promises. Some promoters of these products have been taken into court, convicted, and fined. In many cases the promoters have voluntarily gone out of business and filed a stipulation with the Post Office Department to this effect. In such cases no fraud orders are issued.

*Assignment.*—L. F. Kebler, W. O. Emery.

*Proposed expenditures, 1918-19.*—\$3,000.

### Testing Contract Supplies:

*Object.*—To determine the proper specifications for certain Government contract supplies and whether the goods delivered comply with the specifications.

*Procedure.*—Chemical or physical laboratory tests are made of the samples according to official methods of analysis. Only such materials are examined as foods, drugs, and other articles that come within the scope of the work of this bureau and that, therefore, can not so readily be handled by other branches of the Government.

*Cooperation.*—Departments of the Government and the General Supply Committee.

*Location.*—Washington, D. C.

*Date begun.*—1900.

*Results.*—Specifications have been developed for a large number of items and economies effected by requiring deliveries to conform to specifications. Assistance has been rendered the Quartermaster of the Army in revising specifications. During the past year samples were analyzed for the War Department, Marine Corps, Commissioners of the District of Columbia, General Supply Committee, Panama Railroad, and Food Administration.

*Assignment.*—W. C. Burnet, I. K. Phelps, F. P. Veitch.

*Proposed expenditures, 1918-19.*—\$2,700.

### Miscellaneous Tests:

*Object.*—To assist in classifying various products under the tariff act, and to make chemical analyses for other departments when requested to do so.

*Procedure.*—Samples as submitted by the Treasury or other executive departments are analyzed according to official methods. When no official methods of analysis are available suitable methods are devised.

*Cooperation.*—Treasury and other departments.

*Location.*—Washington, D. C., and branch laboratories of this bureau.

*Date begun.*—1900.

*Results.*—A large number of chemical analyses have been made for and reported to other departments.

*Assignment.*—C. L. Alsberg and chemists in charge of laboratories.

*Proposed expenditures, 1918-19.*—\$1,665.

### [Research.]

### Study of Cereal Dusts in Relation to Thrasher, Mill, and Elevator Explosions:

*Object.*—To study the physical and chemical properties of grain and cereal dusts which occur in the thrashing, storing, handling, and milling of wheat and other cereals, in order to determine the cause of explosions in thrashers, mills, and elevators and to secure knowledge which will lead to the prevention of such explosions.

*Procedure.*—Special investigations are being carried on to determine the cause and methods of prevention of explosions and fires in thrashing machines and harvest fields, especially in the Pacific Northwest. Samples of flour and other cereal dusts as found in thrashing machines, grain elevators, and mills are collected and a complete study of their chemical composition and physical properties made. In addition, the operations of thrashing, storing, and milling wheat and other cereals are investigated and the efficiency of various types of milling equipment studied.



*Cooperation.*—Bureau of Mines, Department of the Interior; Pennsylvania State College; Bureaus of Public Roads, Markets, and Plant Industry; and a large number of grain milling companies throughout the country.

*Location.*—Washington, D.C., and the field.

*Date begun.*—1914.

*Results.*—Devices are being developed to prevent smut-dust explosions in thrashing machines and grain fire losses. These devices are being tested in the Pacific Northwest and other sections under operating conditions and are proving effective. They have been fully described in Department Bulletin 379. Considerable data have been collected regarding dust explosions in mills and elevators, and preliminary recommendations have been made for their prevention. Extensive laboratory work has been done to determine the use of inert gas for the prevention of flame propagation, and a practical method for use in mills and elevators is now being developed. Methods have also been devised for determining the inflammability for various dusts, and many types are being tested. An apparatus is being developed for experimental work whereby it will be possible to use various means of ignition while different amounts of dust are held in suspension.

*Assignment.*—G. A. Hulett and J. K. Clement, Bureau of Mines, and D. J. Price and H. H. Brown, Bureau of Chemistry.

*Proposed expenditures, 1918-19.*—\$9,200.

(See also Supplement—Emergency Activities, p. 564.)

### Investigations of Distinctive Papers:

*Object.*—To devise currency paper very difficult to counterfeit; to give more individuality to bills of different denominations, in order to make "bill raising" more difficult; and to increase the serviceability of currency paper.

*Procedure.*—Confidential; not to the best interests of the Treasury Department to make public.

*Cooperation.*—Bureau of Engraving and Printing, Bureau of Standards, paper makers, currency engravers and printers, and bankers.

*Location.*—Headquarters, Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: The first report to the Secretary of the Treasury (Nov. 7, 1913) recommended distinctive portrait, design, and color of bills of each denomination. A reduction of \$12,500 per year in the cost of currency paper was also effected. Work has been done on developing a practical watermark. Results so far, however, have not been entirely satisfactory but show progress. Considerable assistance was rendered the Bureau of Engraving and Printing in connection with its work on the sizing and handling of distinctive paper.

(2) During 1918: The committee on distinctive paper was not called upon to do work on this project during the past year. Some work was done at the request of the Bureau of Engraving and Printing.

*Assignment.*—F. P. Veitch, Bureau of Chemistry; F. C. Clark, Bureau of Standards.

*Proposed expenditures, 1918-19.*—\$300.

**Total, Collaboration with Other Departments, \$16,865, including \$2,865 statutory (research, \$9,500; regulation, \$7,365).**

[Regulation.]

## TESTING EXPORT FOOD PRODUCTS.

### Testing Export Food Products:

*Object.*—To inspect and test food products intended for export to foreign countries, for the purpose of determining whether the goods will meet the requirements of the country to which consigned.

*Procedure.*—Samples are taken from shipments for export. The samples are subjected to the same tests as those required by the country to which shipped. The cost of examination is paid by the exporter, the fees being turned into the miscellaneous receipts of the United States Treasury.

*Location.*—Washington, D. C., New York, San Francisco, and other points at which branch laboratories are located.



*Date begun.*—1904.

*Results.*—All samples submitted have been analyzed and certificates of tests furnished.

*Assignment.*—B. R. Hart, R. E. Doolittle, R. W. Hilts.

*Proposed expenditures, 1918-19.*—\$4,280.

[Research.]

## POULTRY AND EGG INVESTIGATIONS.

### Research Work; General Laboratory and Field Investigation:

*Object.*—To discover fundamental scientific facts bearing on the preservation of quality and the prevention of decay of poultry and eggs and their products.

*Procedure.*—Laboratory analyses are made and experimental studies conducted in the laboratory and in industrial environments on both a laboratory and a commercial scale. Investigations of the effects of various methods of preserving eggs and poultry are undertaken and laboratory and other methods devised by which researches can be carried on. New lines of work are originated and carried to the point of independent projects. An extensive correspondence is conducted with producers, middlemen, and carriers on subjects connected with the investigations. Two laboratories are maintained, one in the producing district and the other in a large consuming center.

*Cooperation.*—Egg and poultry industry, warehousemen, and carriers.

*Location.*—Laboratories at Philadelphia, Pa., and Indianapolis, Ind.

*Date begun.*—About 1907.

*Results.*—(1) Prior to 1918: Laboratory procedures in chemistry and bacteriology have been adapted to the study of poultry flesh and eggs. New methods have been developed. Practical application of scientific facts to industrial problems has been made, with great improvement in commercial practices, as is evidenced by the gain in quality of such products on the market as cold-stored poultry and eggs. The accuracy and economy of packing-house methods of chilling and dressing poultry and chilling and grading eggs have been greatly improved. Many of the methods now in use are referable primarily to the work of this project. Improved construction of small chill rooms with ice as the refrigerant has been accomplished. Many such rooms are being built. Information has been obtained on the growth of bacteria at various temperatures, which is of especial interest in connection with the preservation of flesh at low temperatures. The dependence of chemical changes in flesh upon temperature has also been studied. Critical analytical work on eggs has been done.

Publications: Bureau of Chemistry Bulletin 115, "A Preliminary Study of the Effects of Cold Storage on Eggs, Quail, and Chickens"; Weekly News Letters—"Government Advice for Poultry Shippers" and "How to Pack Poultry"; press notices—"Don't Buy Water-Logged Poultry," "Farmers Advised Not to Sell Eggs from Incubators," "How to Kill and Bleed Poultry for Market," "Everybody Can Candle Eggs," "Our \$200,000,000 Waste in Eggs," "Housewives Should Buy Chickens Undrawn," "Unprecedented Spoilage of Thanksgiving Poultry," "Water-Soaked Poultry Expensive," and "Directions for Preserving Eggs by Water Glass."

(2) During 1918: Construction and operation of efficient and economical poultry packing houses have been extended. Plans, suggestions, and specialized attention have been given to over 75 shippers. Ice-cooled chill rooms have been more closely studied and further economies effected. The study of humidity in chill rooms and freezers has progressed to the point of sufficiently accurate determinations to apply the methods commercially. This is one of the most important fields of work in connection with low-temperature preservation of perishables. A paper on the "Determination of Loosely Bound Nitrogen as Ammonia in Eggs" has been published.

*Assignment.*—Mary E. Pennington.

*Proposed expenditures, 1918-19.*—\$16,870.



**Investigations of Poultry and Eggs During Transportation:**

*Object.*—To determine the effect of conditions on the keeping quality of poultry and eggs during and subsequent to transportation.

*Procedure.*—Goods are prepared for shipment under exact methods of handling, including a knowledge of their condition as determined by laboratory analyses and inspection. Shipment is made under definite conditions, which are observed and recorded, and their effect upon the product is determined on arrival and during marketing by laboratory methods and inspection.

*Cooperation.*—Bureau of Markets and poultry and egg buyers, shippers, receivers, warehousemen, carriers, and refrigerator-car lines.

*Location.*—Poultry and egg producing territory from Texas to Minnesota and east and west coast cities.

*Date begun.*—1909.

*Results.*—(1) Prior to 1918: Information concerning the preparation of poultry and eggs for shipment has been obtained. The temperatures maintained during transit and their effect on the product have been recorded and discussed in Bureau of Chemistry Circular 64, "Studies of Poultry from the Farm to the Consumer," and in Department Bulletin 17, "The Refrigeration of Dressed Poultry in Transit." Additional information on the relative keeping quality of "wet-packed" dressed poultry in transit, "dry packed" poultry in transit, precooled eggs, and eggs chilled during transit is tending to standardize the transportation of these products. This information is being widely used by shippers and railroads to decrease waste and decay. Observed temperatures have been viewed in the light of car construction. Indications are that changes in construction should be made.

(2) During 1918: The information obtained has led to definite modifications in the construction of refrigerator cars. The work has been recognized by the carriers, and prior to May, 1918, nearly 3,000 cars had been entirely or partially reconstructed in accordance with the findings.

*Assignment.*—Mary E. Pennington, H. A. McAleer, E. C. Heinsohn, C. E. Sidler.

*Proposed expenditures, 1918-19.*—\$2,405.

**Breakage of Eggs in Transit:**

*Object.*—To determine the cause of breakage, fix responsibility, and devise, test, and demonstrate methods by which damage in transit can be reduced.

*Procedure.*—Study is made of egg grading, egg packages, and stowing of loads in shipping sections; of conditions during transit on railroads and in trucks or wagons; and of details of handling at terminals, on docks, and in warehouses, and of handling by receivers.

*Cooperation.*—National Poultry, Butter, and Egg Association; shippers, railroads, egg-packing industry, receivers, warehousemen, and refrigerator-car lines.

*Location.*—Middle West, and east-coast cities.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: Several hundred experimental shipments were made, in car lots, of eggs packed in well-made, standard cases, with "medium" or heavier fillers and flats, so stowed in the car that bracing and buffing absolutely prevented the shifting of the load. With reasonable care to avoid railroad shocks, especially in yard switching, it was shown that transit damage could be kept down to less than 2 per cent. The industry and the carriers have so modified their practices that breakage in transit is much lessened. This is especially noticeable in eggs moving in car lots. Most of the transit damage now is found in less-than-car-lot shipments. The following popular publications were issued: "Test of Egg Cases," Weekly News Letter, May 5, 1915; "Loss in Cracked Eggs," Weekly News Letter, March 15, 1916; and a press notice entitled "Over Two Dozen Eggs in Every Case Broken through Faulty Methods of Packing and Shipment."

(2) During 1918: Observations of many carloads of eggs stowed and packed in accordance with principles laid down prior to 1918 indicated that damage in transit could be very greatly reduced. Accordingly, Department Bulletin 664, "Prevention of Breakage of Eggs in Transit When Shipped in Car Lots," has been published. The heavy losses still



incurred when eggs are shipped in less than car lots are to receive during the coming year as much attention as funds and time will permit.

*Assignment.*—Mary E. Pennington, H. A. McAleer.

*Proposed expenditures, 1918-19.*—\$1,200.

### **Egg Preservation by Refrigeration, Freezing, and Drying:**

*Object.*—To determine the fitness of certain eggs as food and to study their handling before and after refrigerated storage in the shell, freezing, and drying, and their use by the general consumer, bakers, and others, in order to save waste and improve quality.

*Procedure.*—Work is conducted in the laboratory and in packing houses, warehouses, and egg-breaking plants on the grading of eggs before the candle and out of the shell and on their handling, freezing, drying, and storage. Examination is made of the products in the market and in bakeries when subjected to commercial routine handling. Specialized chemical and bacteriological study is given to eggs stored in the shell at low temperatures.

*Cooperation.*—Egg-breaking establishments, bakers, egg shippers, egg receivers, railroads, and cold-storage warehousemen.

*Location.*—East-coast cities and egg-producing sections in the Middle West.

*Date begun.*—1908.

*Results.*—(1) Prior to 1918: Pioneer information has been obtained on the effect of refrigeration on the composition and quality of eggs, both frozen and chilled. This has been published in Bureau of Chemistry Circular 64, "Studies of Poultry from the Farm to the Consumer," and in articles in scientific journals. Bureau of Chemistry Circular 98, "The Preparation of Frozen and Dried Eggs," and Department Bulletins—51, "A Bacteriological and Chemical Study of Commercial Eggs in the Producing Districts of the Central West"; 224, "A Study of the Preparation of Frozen and Dried Eggs in the Producing Section"; 391, "Accuracy in Commercial Grading of Opened Eggs"; and 565, "How to Candle Eggs," give some of the results as applied to eggs preserved by refrigeration, freezing, and drying. Accurate data on egg preservation at temperatures above freezing are being applied by warehousemen and others to maintain quality. Articles in the Weekly News Letter of the department enable the industry to apply the information as soon as it becomes available; for example, Weekly News Letter, vol. 3, No. 32, "Loss in Cracked Eggs," and also press notices, "Wetting Spoils 5,016,000 Dozen Eggs Each Year," and "Tiny Cracks Spoil 13,000,000 Dozen Eggs." The work of recent years on losses in cold storage is now of material assistance to the industry.

(2) During 1918: Additional information has been obtained from the following viewpoints showing the changes in eggs during holding in cold storage: Number of bacteria and chemical deterioration; the effect of washing and "sweating" of shells; the cause of the so-called "cold-storage taste," which develops after long holding; rate of evaporation of eggs; amount of absorption of moisture by egg package; and various other facts of use in egg preservation. This information has now reached the stage where it is being prepared for publication. Assistance has been rendered to a number of firms in establishing egg-breaking plants, including plans for their construction, equipment, and operation. Department Bulletin 663, "Installation and Equipment of an Egg Breaking Plant," will be found particularly advantageous in this connection.

*Assignment.*—Mary E. Pennington, M. K. Jenkins.

*Proposed expenditures, 1918-19.*—\$4,755.

### **Poultry Fleshing:**

*Object.*—To study the behavior during killing, picking, chilling, packing, transporting, storing, and passage through the market of poultry fed after receipt by the packer for increase in weight and quality; and to determine the effect of different foods on poultry during such preparation for market, in the packing house, and during its subsequent journey to the consumer, and the effect of such feeding on its palatability and nutritive value to the consumer.

*Procedure.*—Types of birds suited to feeding are differentiated from incoming stock and those birds discarded which can not be successfully



used in experiments to determine growth acceleration, specialized tissue formers, modification in the composition of the flesh, the distribution of fat, and such other information as may be necessary concerning the exact composition and effect of rations on poultry fed under the conditions and for the purposes stated. The investigations will include a study of methods of administering rations to determine the effect of quantities and frequency of feeding on the quality and composition of flesh; construction or development of quarters and appliances required for the commercial feeding of poultry in large numbers and in the unnatural environment of the packing house in order to procure a flesh of exact and constant composition; determination of the best methods of emptying the intestinal tract during a desirable period preceding slaughter with a minimum loss of flesh; invention or development of special appliances and methods for the killing, bleeding, picking, chilling, and packing of the brittle-boned, tender-skinned, soft-meated birds resulting from heavy feeding in captivity; determination of the effect of transportation temperatures, holding-room temperatures, long-freezer storage, window displays, and the routine of marketing on the stability of the flesh of the dressed bird; and a study of the character of the changes undergone.

*Cooperation.*—Bureau of Animal Industry, Bureau of Markets, poultry packers having feeding stations, railroads, carriers in general, warehousemen, commercial men, jobbers, and retailers. (Nutrition experiments in the Bureau of Chemistry.)

*Location.*—Poultry-packing houses in the West, South, Middle West, and east-coast cities, and bureau laboratories in Indianapolis and Philadelphia.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: A general survey of the field to gather information of a scientific nature bearing on this extensive problem has been made; also a general chemical study of feeding stuffs available for chickens, especially those not desirable as food for other farm animals or for man. There has been an investigation of the sources of comparatively new feeding stuffs for chickens. Data have been obtained on the amount of feed required to produce a pound of chicken, and on the relation between weight gained and food consumed, with the cost of the feed and the labor involved.

Three rations—(a) cornmeal and water; (b) cornmeal and buttermilk; and (c) cornmeal, distillers' grains, and buttermilk—have been used during an entire season for the fleshing of broilers, roasters, and hens under commercial conditions. Good gains were obtained with ration (b), but the best gains were secured with ration (c), which also was the most economical with respect to the percentage of ingested food retained as flesh. During a fleshing period of 14 days the immature birds showed an average gain of over 30 per cent of their initial live weight. The chemical composition of the flesh was distinctly influenced by the ration.

(2) During 1918: The results obtained during the fleshing season of 1916-17 have been published as Department Bulletin 657, "A Wheatless Ration for the Rapid Increase of Flesh on Young Chickens." During the fleshing season of 1917-18 a study was made of rations containing by-product feedstuffs and feedstuffs which are of local economic importance in certain regions of the United States. The efficiency of these rations was measured by comparing their results with those obtained on a ration of cornmeal and buttermilk. The study was undertaken in order to devise satisfactory wheatless rations for fleshing poultry under commercial conditions. Certain of the results have been published, in greatly condensed form, in a department folder entitled "Wheatless Rations to Flesh Young Chickens in Your Feeding Station." The feedstuffs used in the 12 rations there reported were corn-germ meal, dried yeast, ground whole oats, kafir meal, ground barley, rice meal, peanut press cake, dried distillers' grains, and white rot and spot eggs, in addition to cornmeal and buttermilk. A preliminary study was also made of rations containing wet brewers' yeast and dried buttermilk. During a fleshing period of 14 days batteries of immature birds (roasters and broilers) have gained from 23 to 60 per cent, usually over 30 per cent, of their initial live weight. Individual birds have often gained from 60 to 100 per cent of their initial live weight.

*Assignment.*—Mary E. Pennington, H. A. McAleer, E. F. Kohman.

*Proposed expenditures, 1918-19.*—\$9,435.



**Instructing Shippers, Carriers, and Others in Handling Poultry and Eggs:**

*Object.*—To disseminate by personal contact, demonstrations, publications, etc., information obtained through investigations on the principles of handling eggs and dressed poultry, and to confirm the practicability of such principles when applied on a large scale.

*Procedure.*—Meetings are held at shipping and receiving points, presided over by investigators, to which all the industry, the railroad agents, etc., are invited. Visits are made to shippers, receivers, warehousemen, etc., to observe methods in use and obtain and give general information; also trips with the demonstration car carrying a refrigerator plant. Practical demonstrations are given of the application of better methods in houses of cooperating packers, and packers are assisted in building and equipping economical and efficient poultry and egg-packing houses.

*Cooperation.*—Bureau of Markets, buyers, shippers, railroads, warehouses, receivers of poultry and eggs, and State agricultural colleges.

*Location.*—Producing sections of the South, West, and Middle West; east-coast cities; and occasional minor activities in other sections producing or consuming poultry and eggs.

*Date begun.*—About 1910.

*Results.*—(1) Prior to 1918: The scientific information obtained in the investigations has been put into practice in the industry through the practical personal contact of the investigators. This is evidenced by the great improvement in poultry and egg-packing houses and the appliances used in them and in their killing, picking, packing, and general handling routine. It is also seen in the increased interest in better methods and efforts in the line of conservation. County agents, railroad dairy freight agents, commercial poultry supply salesmen, refrigerator supply men, engineers, refrigerator-car builders, and many others whose interests touch poultry and egg handling have been supplied with information which they disseminate, thereby extending its usefulness. The poultry and egg demonstration car has been operated from Texas to northern Indiana, covering a portion of the territory each summer, beginning with the year 1912.

(2) During 1918: The poultry and egg demonstration car was operated in Tennessee, Alabama, Mississippi, and Kentucky. Local demonstrations at many points in the producing section were held and the usual personal visits made. Visits were also made to about 45 plants where eggs were broken for preservation, by freezing, in a territory covering 11 States.

*Assignment.*—Mary E. Pennington, H. A. McAleer, H. C. Pierce, E. C. Heinsohn.

*Proposed expenditures, 1918-19.*—\$10,590.

**Total, Poultry and Egg Investigations, \$45,255, including \$5,255 statutory.**

(See also Supplement—Emergency Activities, p. 577.)

[Research.]

**FISH INVESTIGATIONS.****Freezing and Cold Storage of Fish:**

*Object.*—To study present practices in handling fish for freezer storage, with a view to the prevention of loss through deterioration.

*Procedure.*—Chemical, bacteriological, and histological studies are made of the effects of low temperature and different periods of storage upon fish handled in the commercial way. Trade practices in glazing, gutting, and wrapping fish for storage as a means of preservation are investigated. An effort will be made to devise new scientific methods, if necessary, for detecting changes in fish during storage and for the detection of spoilage.

*Cooperation.*—Fishermen, dealers, and fish freezers, Federal Food Administration, and Bureau of Fisheries.

*Location.*—Philadelphia, New York, and fish-producing points.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: Extensive experiments involving long periods of freezer storage on fish treated in various commercial ways have been in progress. These experiments had to be repeated several years in



succession for confirmation. New chemical methods have been devised to detect incipient deterioration in fish and similar products, and these methods have been successfully applied to the study of oysters and fish under refrigeration.

(2) During 1918: Analytical work was completed on samples of fish held for varying periods of time up to 27 months. A number of species were studied, and there were some variations in packages. The data are being compiled for publication. Bulletin 635, "Commercial Freezing and Storing of Fish," has been issued.

*Assignment.*—Mary E. Pennington.

*Proposed expenditures, 1918-19.*—\$400.

### **Transportation and Handling of Fish:**

*Object.*—To investigate present methods of handling, packing, and shipping fish, in order to devise ways of improving the quality and preventing loss.

*Procedure.*—Chemical and other studies are made of the efficiency of present handling and shipping methods in conserving the quality of fish. Experimental shipments of fish are made and studies of handling conducted in the hope of improving the quality of fish shipped under present methods, as well as under any new methods which may be developed.

*Cooperation.*—Transportation companies and fish dealers.

*Location.*—Fish-producing and consuming centers and their shipping connections in the eastern, middle-western, and Pacific-coast districts.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: Field and laboratory studies have been made of commercial methods of handling and transporting fresh shrimp. The adoption of better handling practices has given a great impetus to the shrimp industry. Complete chemical and temperature data were obtained for the first time on car lots of fish in transit from Florida to New York City.

(2) During 1918: Investigations were made in the markets of the northeast Atlantic coast and results of present market methods of handling studied. The action of melting ice on dead fish was under investigation. Investigation was also made of the effect on keeping quality of quick chilling, gentle handling, and the absence of such common practices as "forking," "hooking," etc. The bacteria of the intestinal tract of salt-water fish and the bacteria of "fish slime" have been studied.

*Assignment.*—Mary E. Pennington, G. D. Horton, C. C. LeFebvre.

*Proposed expenditures, 1918-19.*—\$10,895.

### **Systematic Food Analysis of Fish:**

*Object.*—To conduct chemical analyses of all available food fishes to determine their food value and seasonal variations in composition.

*Procedure.*—Complete analyses of all available species of fish from the point of view of their food value are made and compiled. The seasonal and local variations in the chemical composition of fish and the constants of their different food components are studied.

*Cooperation.*—Fish producers and dealers.

*Location.*—Philadelphia, Pa.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: Complete analyses of many species of food fish have been made and compiled. These show that the analytical tables already published are very inaccurate, because the fish were not analyzed at different seasons and the yearly average obtained.

(2) During 1918: A paper entitled "A Chemical Study of Food Fishes: The Analysis of Twenty Common Food Fishes with Especial Reference to a Seasonal Variation in Composition" has been published in the Journal of Biological Chemistry, vol. 33, No. 3, March, 1918. A considerable number of fish from the Gulf of Mexico, both those commonly considered edible and new varieties, have been analyzed.

*Assignment.*—Mary E. Pennington, C. C. LeFebvre.

*Proposed expenditures, 1918-19.*—\$4,780.

### **Fish By-Products and New Sea Foods:**

*Object.*—To investigate the utilization of fish waste products and new foods from fish, shellfish, and their commercial products.



*Procedure.*—Chemical and other studies are made in the laboratory and field, looking to the development of commercial uses for fish oils, glue, gelatin, waste, etc. New uses of fish and fish products as foods or for other purposes will be developed after chemical study and practical work with the fish industries.

*Cooperation.*—Bureau of Fisheries, fish dealers, and the fish by-product industry.

*Location.*—Bureau laboratories and fish-producing points on the east and west coasts.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: The chemical constants and viscosities of the oils of many species of fish have been determined and tabulated. Data have been obtained on the properties and value of salmon oils for industrial uses.

(2) During 1918: General information was accumulated on the utilization of fish waste in a survey of the Atlantic and Gulf coasts. Especial attention was paid to the possibilities of developing the canning of fish, and the production of fish, porpoise oil, and fertilizer on south Atlantic and Gulf coasts.

*Assignment.*—Mary E. Pennington.

*Proposed expenditures, 1918-19.*—\$400.

**Total, Fish Investigations, \$16,475, including \$2,475 statutory.**

(See also Supplement—Emergency Activities, p. 578.)

## OYSTER AND OTHER SHELLFISH INVESTIGATIONS.

### [Regulation.]

#### **Investigations Regarding the Sanitary Inspection of Shellfish Areas and the Handling and Shipping of Shellfish:**

*Object.*—To obtain information looking to the improvement of the sanitary quality of shellfish reaching the market.

*Procedure.*—The work includes a sanitary survey of oyster and clam beds and studies of shellfish in the various stages of marketing.

*Cooperation.*—Hygienic Laboratory, State shellfish commissions, and State boards of health.

*Location.*—Headquarters, Washington, D. C.; field laboratories established in locations favorable to the study of the shellfish industry.

*Date begun.*—1913.

*Results.*—The work of the past year has been limited to the enlargement of our knowledge of special areas of pollution in the oyster producing regions. Certain areas dangerously polluted have been visited, the conditions determined, and efforts made, in cooperation with State and local authorities, to improve conditions.

*Assignment.*—P. B. Parsons, A. C. Hunter.

*Proposed expenditures, 1918-19.*—\$5,745, including \$745 statutory.

**(Investigations Regarding the Conservation of the By-Products of the Oyster Industry:** Project suspended. It is not contemplated that it will be possible to undertake work along this line for two or three years.)

**(Investigation of the Cleansing of Oysters:** This project has been completed and the results prepared for publication. The object of the investigation was to determine the efficiency, from a sanitary standpoint, of the various methods of washing and cleansing oysters and at the same time to obtain data relative to the changes which occur in the oysters, particularly as to gain in volume and loss of solids as a result of the washing process.)

### [Research.]

## BIOLOGICAL INVESTIGATIONS OF FOOD AND DRUG PRODUCTS.

### **Chemical Investigations of Vegetable Proteins:**

*Object.*—To determine the chemical composition of proteins as a basis for ascertaining their food values; to investigate the hitherto unknown nitrogenous constituents of seeds and plants; to examine seeds and plants which are at present not used for foods; to ascertain whether these



contain compounds which might be used to supplement the deficiency of other foods; to develop methods for the analysis of proteins; and to test the nutritive value of proteins by means of feeding experiments.

*Procedure.*—Proteins are isolated from seeds and plants and a chemical study made of them. Nutrition experiments are carried out to determine the food value of proteins.

*Cooperation.*—Bureau of Animal Industry.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—The second of a series of papers on the proteins of the peanut, *Arachis hypogaea*, was published in the Journal of Biological Chemistry, vol. 30, May, 1917, under the title "The Distribution of the Basic Nitrogen in the Globulins Arachin and Conarachin." A summary of the work on the proteins of the peanut was published in the Proceedings of the National Academy of Sciences, vol. 3, p. 365, May, 1917.

The globulin of buckwheat, *Fagopyrum fagopyrum*, has been isolated and analyzed. A chemical study of this protein shows that it contains all the basic amino acids usually present in proteins and that the lysine content (7.9 per cent) is very much higher than in the cereals. A paper on this subject was published in the Journal of Biological Chemistry, May, 1918.

The globulin of the Chinese velvet bean, *Stizolobium niveum*, has been isolated. A chemical study shows that this protein contains an abundance of the basic amino acids necessary to promote growth. Data on this subject were published in the Journal of Biological Chemistry, May, 1918.

A complete hydrolysis of kafirin, the principal protein of kafir, *Andropogon sorghum*, has been completed, and the amino acids have been isolated. This study shows that kafirin is closely related to zein from maize, but contains the two important amino acids, lysine and tryptophane, which are not present in zein. A paper on this subject is ready for publication.

A complete hydrolysis of arachin, the chief protein of the peanut, *Arachis hypogaea*, has been completed, and a paper is ready for publication.

The chemistry of the cotton plant has been studied further, and preliminary work has been done on the volatile oil. A paper on the chemistry of the cotton plant, *Gossypium herbaceum*, was published in the Journal of Agricultural Research, May, 1918.

In cooperation with the Bureau of Animal Industry, feeding experiments were made for the purpose of ascertaining the value of peanut meal as a concentrate in the production of milk. The results obtained indicate that peanut meal is a very excellent feed for milch cows.

The following work is now in progress: A continuation of the study of the proteins of velvet beans; a chemical and biological study of the proteins of the coconut and coconut press cake; study of the distribution of the nitrogen in the proteins of several varieties of beans; study of the tyrosine, proline, and aspartic acid content of the alcohol-soluble proteins of cereals; development of improved methods for the analysis of proteins; nutrition experiments to determine the food value of proteins and protein concentrates.

*Assignment.*—C. O. Johns, D. B. Jones, A. J. Finks, C. E. F. Gersdorff.

*Proposed expenditures, 1918-19.*—\$15,600.

**(Nitrogen Distribution in Various Cereals and Other Feeding Stuff: Project completed.** A number of seeds and one isolated protein were analyzed. The results of the work are ready for publication. The conclusion has been reached that the Van Slyke method is not applicable, with accuracy, to the analysis of whole seeds.)

#### **Effect Upon Health of Feeding Small Quantities of Saponins for Long Periods:**

*Object.*—For some years saponins have been used in various food products, notably in soft drinks for the purpose of making them foam. "Saponin" is a term covering a wide range of compounds, many of which are extremely poisonous and all of which possess the power in very great dilution of dissolving red blood corpuscles. The use of certain saponins in food products is undoubtedly objectionable. Whether others less toxic



are permissible is open to question. All the experimental work with saponins hitherto recorded has been done with large doses, so that no conclusions can be drawn as to which are of value in guiding this bureau in the enforcement of the food and drugs act. In the proposed experiments small dosages, comparable with those in foods, will be employed in order to guide action in reference to the use of saponins. An effort will be made to determine whether the toxicity of different saponins as measured by their hemolytic power has any relation to the surface tension of the concentration that causes hemolysis. The results should be of value in the estimation of saponins.

*Procedure.*—Inasmuch as the feeding of small quantities of saponins to animals over long periods is often without visible effect, and inasmuch as the chief toxic action of saponins is on red blood corpuscles, it is proposed to feed animals for long periods with small quantities of saponins and then examine the resistance of their red corpuscles to laking. The manner in which the saponins are eliminated from the digestive tract will also be investigated.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: The results obtained indicate that there is a distinct effect upon the red corpuscles, which is more marked in some cases than in others. The surface tension of solutions of about 10 saponins has been measured and the concentrations that cause hemolysis determined. There is a great difference in hemolytic activity, some saponins causing hemolysis in concentrations of five parts per million and others only in concentrations of several thousand parts per million. The surface tension of water is reduced by 10 to 20 per cent by saponins when present in a concentration of 100 parts per million.

(2) During 1918: Several more saponins have been examined, and one was found which has no hemolytic action on the red blood corpuscles, although it lowers the surface tension of water to about the same extent as do the other saponins. There appears to be no relation between the hemolytic activity and the surface tension of saponin solutions.

*Assignment.*—C. L. Alsberg and assistants.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

**(Utilization of Hydrogenated Oil: Project completed. The results of this investigation will be published later.)**

**Total Biological Investigations of Food and Drug Products, \$15,600, including \$600 statutory.**

[Research.]

## INVESTIGATIONS OF CITRUS BY-PRODUCTS AND OF METHODS FOR DETERMINING MATURITY IN FRUITS AND VEGETABLES.

### Citrus By-Products Investigations:

*Object.*—To devise commercial methods for the utilization of cull citrus fruits.

*Procedure.*—These investigations include studies of devices for separating essential oil from the peel, with a view to increase the quality and quantity of the product; development of methods for the preparation of citrus-fruit juices and their blending with the juices of other fruits; determination of methods for the production of citrate of lime and citric acid and for the crystallization and granulation of the latter product, and of methods for the elimination of heavy metals in citric-acid solutions, including a search for resistant alloys and enamels; also a study of methods for the production of acetic acid, alcohol, and acetone by the destructive distillation of residues from citric acid manufacture, and a study of the possibility of producing commercial marmalade stock by the evaporation of citrus fruit *in vacuo* and of producing citrus-fruit pectin. The preservation of juice and pulp by freezing for use in the production of food material will be investigated. A study will be made of the manufacture and concentration of distilled oil from the residues of orange and lemon peel and the preparation of candied peel; also an investigation of the handling of cull fruit from the grove to the by-product factory and of methods of packing and handling citrus by-products.



*Location.*—Los Angeles, Cal.

*Date begun.*—1911.

*Results.*—The work on the manufacture of citrate of lime is completed. Both the quantity and quality of the product have been increased and bettered as a result of the application of methods developed through these investigations. The citric acid study is 90 per cent completed. Work on the elimination of heavy metals and the search for resistant alloys and methods of crystallization has been carried on. The study of the manufacture of vinegar from orange juice is practically completed, and samples have been introduced to the trade. Work on the manufacture of vinegar in continuous generators was inaugurated but has been allowed to lapse owing to the scarcity of fruit.

Studies in granulation of citric acid have been inaugurated. The preparation of frozen orange pulp was begun, but an initial shipment sent to the middle-western market resulted in a failure owing to the lack of proper storage conditions in transit. This work will be undertaken again as soon as fruit is available and proper storage can be secured. Considerable quantities of crystallized grapefruit peel have been produced and samples distributed in the trade. The present scarcity of sugar and the regulation of its use will probably seriously affect the introduction of this product. The machine for removing the pulp from oranges and lemons is practically completed. It has had several trials, which have shown minor defects that are being remedied, and the device will soon be operated on large-scale experiments. The device for extracting essential oils from peel has also advanced sufficiently far to make preliminary trials. These have shown it to be correct in principle, and the defects which have developed do not seem difficult to overcome. Work was inaugurated on the preparation of bottled grapefruit juice, as well as blends of grapefruit with other juices, and considerable progress has been made. Investigations on the destructive distillation of the residues from citric-acid factories have been inaugurated but during the past year have been confined to the study of methods used on similar products in the trade. A publication on the manufacture of citrate of lime and citric acid is in course of preparation. The investigation of the relative oil and citric-acid contents of lemons at different times of the year and in different localities has been completed and a paper prepared for publication.

*Probable date of completion.*—1920.

*Assignment.*—E. M. Chace, Homer D. Poore.

*Proposed expenditures, 1918-19.*—\$7,620.

### **Investigations of Maturity of Fruit and Vegetables:**

*Object.*—To investigate the composition of citrus, deciduous, and other fruits and vegetables with a view to ascertain the best harvesting time for consumption, storage, or transportation.

*Procedure.*—Studies are being made of the composition of various fruits and vegetables during the period of their growth when the question of harvesting is paramount. The effect of storage and shipment upon composition is being studied, as well as the composition at all stages of growth. Fruits which have so far been investigated are those of the citrus group and the cantaloupe. Preliminary investigation of the Bartlett pear has also been undertaken.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Los Angeles, Cal., Gainesville, Fla., and other points in California and Florida.

*Date begun.*—1913.

*Results.*—The work on the California navel orange has been completed, and the results of the investigations have been prepared for publication.

The work on California grapefruit has been completed and a paper describing some of the results submitted for publication. Considerable time has been devoted to the study of the maturity of Florida oranges and grapefruit, the data obtained now being placed in shape for detailed study. The work in cooperation with the Bureau of Plant Industry on the composition of bud variations of citrus fruits has reached a stage where the field work has been suspended and attention turned to compiling results, with a view to develop the work upon the progeny of the



parent trees which have been studied. A preliminary publication of the results is in the course of preparation.

The study of the maturity of cantaloupes was continued at Brawley, Turlock, Phoenix, and Rocky Ford, and it is hoped that the discoveries made may be tried out in the field during the present season. The work will be handicapped by the loss of the plant physiologist who was attached to this laboratory. Work on avocados has been suspended owing to lack of fruit. The analyses of the material on hand will be completed before the end of the fiscal year and the results offered for publication as soon as practicable.

*Assignment.*—E. M. Chace and assistants.

*Proposed expenditures, 1918-19.*—\$9,340.

### **Study of the Effect of Freezing on the Composition of Oranges and Lemons:**

*Object.*—To investigate the effect of freezing, both naturally and artificially, on the composition of citrus fruits, with a view to the detection of frozen fruit and its elimination in commercial shipments.

*Procedure.*—Oranges and lemons are artificially frozen upon the tree and chemical studies made to determine the effect of such treatment on the composition of the fruit as a basis for the detection and elimination of frozen and consequently inferior fruit.

*Location.*—Los Angeles, Cal., and other points in the field.

*Date begun.*—1916.

*Results.*—Preliminary work was undertaken after the cold weather of the 1916-17 season. The results obtained by commercial separators were carefully studied and considerable data of value accumulated. The work was discontinued at that time owing to the loss of the services of the plant physiologist who was assisting in the project.

*Assignment.*—E. M. Chace.

*Proposed expenditures, 1918-19.*—Nominal; cost of work included in allotments to other projects.

**Total, Investigations of Citrus By-Products and of Methods for Determining Maturity in Fruits and Vegetables, \$16,960, including \$3,960 statutory.**

[Research.]

## **COLOR INVESTIGATIONS.**

### **Investigation of Color Substances:**

*Object.*—To investigate the formation of color substances from raw materials, principally of American origin. Problems in plant physiology and plant production will not be undertaken except through cooperation with the Bureau of Plant Industry. A considerable portion of the work will deal with equilibria reactions for the purpose of investigating conditions of formation and yields.

*Procedure.*—A building is in process of erection at the Arlington Farm, in which technical apparatus will be installed to carry on experimental work on a manufacturing scale. Such installations are necessary, since many chemical reactions which are successfully carried out on a laboratory scale need many modifications to meet manufacturing requirements. Research laboratories will also be established in this building.

*Cooperation.*—Cooperation has been arranged with several manufacturers to test promising processes which have been developed on a laboratory scale by members of the staff. It is contemplated that cooperation will be arranged with other bureaus of the Government when deemed advisable.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1916.

*Results.*—(1) Prior to 1918: Personnel, building, and equipment were arranged. Chemical investigations so far have been made in the laboratories of the Bureau of Chemistry. These have included chlorination processes, oxidation reactions and the manufacture of a number of dyes and intermediate products. As a result of the work four patent applications were made and the preparation of several articles for publication started.



(2) During 1918: Progress has been made in many lines of investigation. The following articles have been recommended for publication: "Detection of Added Color in Butter or Oleomargarine," "Note on the Fundamental Polyhedron of the Diamond Lattice," "The Quantitative Estimation of Anthraquinone," and "Para Cymene. I. Nitration. Mononitrocymene, 1-CH<sub>3</sub>, 2-NO<sub>2</sub>, 4-CH (CH<sub>3</sub>)<sub>2</sub>." Many other articles are in course of preparation. Approximately fourteen applications for patents have been filed, of which one has been issued and six others have been allowed.

*Assignment.*—H. D. Gibbs.

*Proposed expenditures, 1918-19.*—\$76,890, including \$6,170 statutory.

[Research.]

### TABLE SIRUP INVESTIGATIONS.

#### Investigations in Cane Sugar, Sirup, and Molasses Manufacture:

*Object.*—To obtain for analysis genuine samples of cane sirup from makers in various parts of the sugar-cane belt; to determine the influence of seasonal variations and of cane varieties on the composition of the product; to ascertain the effect of various methods of manufacture on the products; to study the use of new methods of clarifying and filtering cane sirup; to determine the possible use of invertase and other inverting agents in preparing cane sirup which will not granulate or ferment; and to demonstrate the above methods to cane-sirup makers and others.

*Procedure.*—As much of the experimental work as possible is carried out during the rather short cane-grinding season in the fall. Laboratory studies upon methods of inversion, clarification, and filtration are performed at Washington during the remainder of the year.

*Cooperation.*—Sirup makers in the sugar-cane belt; Office of Sugar-Plant Investigations, Bureau of Plant Industry.

*Location.*—Washington, D. C., and points in the field.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: The influence of the various varieties of cane and the effect of their growing in different localities upon the color, composition, and quality of the sirup was studied. A method was worked out in the laboratory by which a clear, light-colored sirup can be made by producers having a small factory equipment. It was found that a sirup of very uniform density could be manufactured by using the boiling point as a criterion of this quality. Good progress was made in the preparation in large quantities and the use of invertase in the manufacture of cane sirup.

(2) During 1918 experiment stations were established at Cairo, Ga., St. Elmo, Ala., Franklin, La., and Kirbyville, Tex.

At Cairo, Ga., the juice was evaporated on a continuous baffle-plate evaporator, with skimming to a density of about 35° Brix, run through filtering bags into wooden cisterns, there treated with invertase, the final evaporation to sirup being carried out the next day on a continuous evaporator. By this method a sirup was made which will not crystallize and, judging from samples made by the same process last year, will not readily ferment.

At St. Elmo, Ala., practically the same method of work was carried on.

At Kirbyville, Tex., aid was given farmers in establishing a cooperative sirup canning plant. The necessary equipment was installed and successfully operated.

At Franklin, La., experiments in clarification of cane juice were carried on. It was found that by the addition of a small amount of infusorial earth to the cane juice it could then be filtered through a filter press, the resulting juice being brilliantly clear. This method of clarification, together with the use of invertase to prevent crystallization, produced a sirup that was clear, light-colored, heavy-bodied, and of a very agreeable flavor.

*Probable date of completion.*—1921.

*Assignment.*—C. S. Hudson, J. K. Dale.

*Proposed expenditures, 1918-19.*—\$7,875, including \$875 statutory.

(See also Supplement—Emergency Activities, p. 577.)



## ENFORCEMENT OF THE FOOD AND DRUGS ACT.

[Regulation.]

## ADMINISTRATION.

**General Administration of Import Features of Food and Drugs Act:**

*Object.*—Consideration of general matters of policy, general rulings, and interpretations of the act in their application to imports, and preparation of service announcements dealing with such matters; unification of action at various ports; consideration of representations made by foreign governments through State Department; review of findings on imported food and drug products; consideration of cases on appeal from decisions of district chiefs and of cases presented by Treasury Department involving violation of penal bonds given at time of entry; preparation of correspondence relating to the application of the law to imported products.

*Cooperation.*—Solicitor of the department.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Assignment.*—C. L. Alsberg, W. G. Campbell, A. E. Taylor.

*Proposed expenditures, 1918-19.*—\$8,000.

**General Administration of Domestic and Export Traffic in Food and Drug Products:**

*Object.*—Determination of general policy; preparation of service announcements and similar rulings; supervision of field activities in connection with the enforcement of the act; review of cases; preparation of evidence, notices of judgment, and correspondence relating to the application of the act.

*Cooperation.*—Solicitor of the department.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Assignment.*—C. L. Alsberg, W. G. Campbell, P. B. Dunbar, M. Boyle, C. W. Crawford.

*Proposed expenditures, 1918-19.*—\$14,501.

**Collaboration with State Officials:**

*Object.*—To secure collaboration with State food, drug, dairy, and feeding-stuffs officials in order more efficiently to enforce the food and drugs act.

*Procedure.*—This project involves the collection and dissemination of information relating to methods of analysis, definitions, standards, and administrative problems, and the preparation of the Monthly Review of the Bureau of Chemistry for the information of the members of the bureau and of the city and State food and drug control officials with whom cooperative arrangements have been established for the enforcement of food and drug laws.

*Cooperation.*—Food, drug, dairy, and feeding-stuffs officials of various States and cities.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—The plan of cooperation between city, State, and Federal food and drug control officials has been enlarged and extended. Useful scientific information relating to the composition and analysis of foods and drugs compiled by the Bureau of Chemistry under the designation "Information Cards" has been forwarded to State officials. Many city and State officials are now securing evidence of violations of the food and drugs act, which has resulted in a more efficient enforcement of the act. Federal officials, in turn, notify city and State officials of violations of city ordinances and State laws relating to foods and drugs. Factory inspection reports are exchanged. The city, State, and Federal inspectors and chemists have made many joint inspections and investigations concerning the analysis, production, storage, and transportation of foods and drugs. A clearing-house letter was inaugurated on January 2, 1917, for the purpose of keeping all food and drug control officials informed concerning city, State, and Federal food and drug cases, court decisions, opinions of food and drug officials, plans of work, new problems, new legislation, definitions, and standards. Several associations of food



- and drug officials have been formed of small groups of States that have many problems in common, for the purpose of making plans for the enforcement of food and drug laws. One hundred and thirty-four cases were developed by city and State officials during the fiscal year ending June 30, 1917, for violations of the food and drugs act.

*Assignment.*—J. S. Abbott, W. C. Burnet.

*Proposed expenditures, 1918-19.*—\$14,980.

#### **Interstate Records:**

*Object.*—To keep accurate records of interstate cases under the food and drugs act.

*Cooperation.*—Solicitor of the department.

*Location.*—Washington, D. C.

*Date begun.*—1908.

*Assignment.*—S. T. Cabell.

*Proposed expenditures, 1918-19.*—\$17,800.

#### **Compilation of Information Regarding Food and Drug Products for Use in Enforcing the Food and Drugs Act:**

*Object.*—A mass of information has accumulated in the files of the Bureau of Chemistry for a number of years, but is not accessible either for workers in the bureau or for workers on related subjects outside the bureau, because it is not in available form. This material will be compiled for distribution to chiefs of inspection districts, chiefs of stations, and chemists of the Bureau of Chemistry, in the enforcement of the food and drugs act, and also to State and city chemists engaged in the enforcement of State and municipal laws concerning foods and drugs. Such parts of the material as may be considered of sufficient value will be prepared for publication.

*Procedure.*—Information such as is believed to be of practical assistance to analysts and others engaged in the enforcement of the food and drugs act will be compiled after a search of the literature and the files of the bureau and consultation with all available experts and specialists, and will be issued in the form of multigraphed information sheets to Federal, State, and city officials engaged in the enforcement of food and drug laws. The scope and arrangement of the information on the sheets will be about as follows: (1) Methods of analysis, with references; (2) interpretation of results: (a) known forms of adulteration, (b) authentic analyses, (c) discussion, and (d) standards; (3) typical cases, including notices of judgment and court decisions.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918 information on about 110 subjects was compiled and distributed.

(2) During 1918 information on the following additional subjects was issued: Allspice, pimento, cassia, cinnamon, cloves, ginger, prepared mustard, cocaine, and codeine. In addition, a number of the older sheets have been reissued, either without change or after revision where revision was desirable to bring the information up to date.

*Assignment.*—R. W. Balcom.

*Proposed expenditures, 1918-19.*—\$1,610.

**Total, Administration, \$56,891, including \$21,350 statutory.**

#### **FOOD CONTROL.**

##### **Investigation and Compilation of Data Relating to Foods:**

*Object.*—To solve those problems which arise from time to time in the enforcement of the food and drugs act, in order that definite control methods and a uniform administrative policy may be given to the field force.

*Procedure.*—Investigations of various foods are made. These include studies of trade conditions in which the food industries cooperate. The results of such work are compiled and referred to all regulatory subdivisions of the bureau.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—During the past year a monthly average of about 280 interstate cases and cards passed through the office for review, a majority of



which were abstracted in this office. A monthly average of 175 letters and 75 intrabureau memoranda were prepared. Data were compiled on many subjects and, when warranted, appropriate opinions for publication in the Service and Regulatory Announcements were prepared. Where necessary, analyses were made in the laboratory.

*Assignment.*—I. K. Phelps.

*Proposed expenditures, 1918-19.*—\$10,770.

### **Examination of Waters and Related Products:**

*Object.*—To make analyses of interstate and import samples and samples from source, review cases, handle correspondence, complete data for court cases, etc.

*Procedure.*—Samples collected by inspectors of presumably misbranded or adulterated products are analyzed. The sources of waters are inspected to determine the possibility of contamination or other adulteration.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—Numerous successful prosecutions of adulterated or misbranded products have been made. However, very general compliance with the law is being secured. The sanitary condition of waters sold in interstate commerce and imported from abroad is being carefully controlled, the general condition being satisfactory.

During the fiscal year 1918 especial emphasis was given to the development of cooperative work with State food and drug authorities in order to efficiently control products which are sold only to a limited extent in interstate commerce.

*Assignment.*—W. W. Skinner, J. W. Sale.

*Proposed expenditures, 1918-19.*—\$8,200.

### **Examination of Stock Foods and Grains:**

*Object.*—To undertake, in collaboration with the field force, the solution of those problems which arise in connection with the enforcement of the food and drugs act, make analyses of interstate and import samples, review cases, and prepare correspondence concerning pending cases and all questions arising in connection with stock foods and grains.

*Procedure.*—Samples of cattle foods and grains offered for import and found in interstate commerce are collected and examined to determine whether they are in compliance with the provisions of the food and drugs act. Investigations are made of stock feeds, including studies of trade conditions.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—General compliance with the law is being obtained. A special campaign against oats adulterated with water, barley, and screenings was made during 1916 and 1917 and great improvements brought about in these particulars. Special campaigns were also carried on in 1917 and 1918 against cottonseed meals which were falsely branded relative to composition, and linseed meals adulterated with screenings oil feed.

*Assignment.*—J. K. Haywood, G. L. Bidwell.

*Proposed expenditures, 1918-19.*—\$9,125.

### **Preparation of Cases and Correspondence Relating to Carbohydrate Products:**

*Object.*—To review cases and cards, prepare correspondence, including replies to miscellaneous letters, make check analyses of official samples, and compile data for court cases in connection with the enforcement of the food and drugs act.

*Procedure.*—Interstate cases regarding confectionery, sugars, sirups, jellies, jams, preserves, etc., are referred to this laboratory for recommendation as to their disposition. Correspondence dealing with cases, cards, labels, and other food questions arising under the food and drugs act is prepared. Check analyses of official samples are made, when necessary, by men specially experienced along specific lines. Data for use in court cases and in reaching decisions on questions arising under the act are compiled.

*Location.*—Washington, D. C.

*Date begun.*—1914.



*Results.*—During the past year approximately 250 cases and cards were reviewed and 47 letters and 67 memoranda in connection with them prepared. Thirteen notices of judgment were reviewed. Approximately 150 letters and memoranda a month exclusive of those relating to cases, cards, labels, etc., were prepared.

*Assignment.*—C. S. Hudson.

*Proposed expenditures, 1918-19.*—\$4,585.

#### **Microchemical Examination of Food and Drug Products:**

*Object.*—To make analyses of interstate and import samples, review cases, handle correspondence bearing upon the microscopical examination of samples, and perform other necessary microchemical work in connection with the enforcement of the food and drugs act.

*Procedure.*—Samples are examined microscopically and other necessary work performed in connection with cases.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—(1) Prior to 1918: Many prosecutions have been brought as a result of these examinations. Among the more important classes which have been handled are eggs, spices, tomato products, dried fruits, various drug products, pork and beans, nuts, and a number of stock foods.

(2) During 1918: Samples of various kinds were examined, both as the original and also in some cases as check analysis. Where findings justified prosecutions under the food and drugs act, such action was recommended.

*Assignment.*—B. J. Howard.

*Proposed expenditures, 1918-19.*—\$7,475.

#### **Microbiological Examination of Foods and Drugs:**

*Object.*—To make analyses of samples, review cases, handle correspondence, and conduct other necessary work in connection with the microbiological examination of foods and drugs, with reference to the enforcement of the food and drugs act, in order to give the field regulatory force definite control methods and an administrative policy.

*Procedure.*—Samples of foods and drugs are examined and cases developed on those warranting action under the food and drugs act. The analysts appear as witnesses when required.

*Location.*—Headquarters at Washington, D. C.; temporary laboratories in other cities.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: Bacteriological analyses of official samples of foodstuffs in which filth, decomposition, or putridity is suspected have been made. Tomato products, sardines, condensed milk, dried and frozen eggs, and oysters have furnished samples calling for expert interpretation. Miscellaneous samples have been analyzed as fully as information has permitted. Culture media for the Washington, New York, and Chicago branch laboratories and for various field parties have been prepared.

(2) During 1918: In addition to routine regulatory work, an extensive investigation of the causes and nature of decomposition in frozen eggs was carried out and the results submitted for publication.

*Assignment.*—Charles Thom.

*Proposed expenditures, 1918-19.*—\$9,660.

#### **Nitrogen Determinations:**

*Object.*—To determine the nitrogen content of various food and drug products submitted by other laboratories, and to study various modifications of the Kjeldahl method.

*Procedure.*—Official modifications of the Kjeldahl method and of other methods are employed in the determination of the nitrogen content of the samples submitted.

*Location.*—Washington, D. C.

*Date begun.*—1911.

*Results.*—This bureau has collaborated with other bureaus of this and of other departments in determining the nitrogen content of various food and drug products for regulatory and investigational purposes. The efficacy of sodium sulphate has been investigated, and as a result it



has replaced the more expensive potassium sulphate in the usual routine work. Mercury has been shown to be of more value than copper as a catalyst.

*Assignment.*—I. K. Phelps.

*Proposed expenditures, 1918-19.*—\$3,830.

#### Miscellaneous Tests:

*Object.*—To make chemical analyses of foods and other products submitted by other executive departments or other bureaus or which may be assigned by the chief of the Bureau of Chemistry for the benefit of the public service.

*Procedure.*—Analyses are made by official methods when required; otherwise by the most suitable methods available.

*Location.*—Washington, D. C.

*Date begun.*—1900.

*Results.*—A large number of chemical analyses have been made for and reported to other departments.

*Assignment.*—I. K. Phelps.

*Proposed expenditures, 1918-19.*—\$3,580.

#### Carbon and Hydrogen Determinations:

*Object.*—To determine carbon and hydrogen in food samples submitted for examination in connection with the enforcement of the food and drugs act.

*Procedure.*—The usual laboratory methods are followed where applicable; otherwise suitable methods are devised.

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Results.*—Many samples have been examined and methods of analysis improved.

*Assignment.*—I. K. Phelps.

*Proposed expenditures, 1918-19.*—\$670.

**Total, Food Control, \$57,895, including \$13,075 statutory.**

#### DRUG CONTROL.

##### Expert Review of Analyses, Correspondence, and Recommendations on Drug Samples:

*Object.*—To secure the uniform, consistent, and effectual enforcement of the food and drugs act in its application to drugs, and to conduct correspondence relating thereto.

*Procedure.*—The analytical findings and recommendations of inspection districts in connection with evidence presented at hearings are critically reviewed and recommendations made as to the disposal of the cases involved.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—Gradual improvement in the quality and labeling of drugs has resulted.

*Assignment.*—M. W. Glover, detailed from the Bureau of Public Health Service of the Treasury Department; Martin Cooley and A. J. McIntyre, of the Bureau of Chemistry.

*Proposed expenditures, 1918-19.*—\$3,350.

##### Drug Analyses:

*Object.*—To conduct analyses of interstate and import drugs and drug products to determine whether such products are in compliance with the requirements of the food and drugs act.

*Procedure.*—Established methods of analysis are employed where available; otherwise new methods are devised and used.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—The results of these analyses have been used as a basis for action in the enforcement of the food and drugs act and also, in cooperation with other departments, in the enforcement of various other laws.

*Assignment.*—L. F. Kebler, W. O. Emery, E. K. Nelson, C. D. Wright, S. Palkin, W. F. Kunke, W. Heath.

*Proposed expenditures, 1918-19.*—\$7,225.

**Examination of Turpentine and Rosin:**

*Object.*—To examine turpentine and rosin samples to determine whether or not they are adulterated, to check analyses, and to pass upon turpentine and rosin cases under the food and drugs act.

*Procedure.*—Established methods of analysis will be employed where available; otherwise newly developed methods will be used.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Results.*—Examination has been made of samples taken from interstate shipments and the results reported for use in enforcing the food and drugs act in its application to rosin and turpentine.

*Assignment.*—F. P. Veitch.

*Proposed expenditures, 1918-19.*—\$500.

**Crude Drug Control:**

*Object.*—To inspect imported drugs arriving at ports where drug-inspection facilities are limited; to check important work on import and interstate cases; and to prepare standards and collect data, with the object in view of securing uniformity in drug inspection.

*Procedure.*—The usual methods of pharmacognostic investigations are followed.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—Data have been collected for the guidance of administrative offices in enforcing the food and drugs act in its application to crude drugs. Considerable work on standards for crude drugs has been completed and published.

As a result of surveys of some of the crude drugs on the market the following findings may be noted:

(1) Of nine samples of *Strophanthus* seed, only three were obtained from the official species *Strophanthus kombé* and *Strophanthus hispidus*, the remainder being obtained from the nonofficial species, *S. gratus*, *S. sarmentosus*, and *S. courmantii*. These samples, especially those labeled "*Strophanthus hispidus*," usually proved to be mixtures of different species.

(2) Of seven samples of *Aspidium* U. S. P., only four were found to be obtained from the official sources *Dryopteris filix-mas* (Linne) Schott or *Dryopteris marginalis* (Linne) Asa Gray (Fam. Polypodiaceae). One was derived from another *Aspidium* species and two from species belonging to the genus *Osmunda*. All the samples were old and of objectionable quality.

(3) The condition in which certain domestic drugs are collected has not been markedly improved. Golden seal rhizome, for instance, was found to contain an excess of ash, and in the case of pennyroyal leaves the general conditions found were such that a definite standard was proposed, limiting the amount of total ash and acid-insoluble ash (sand).

(4) The survey made of *Viburnum opulus* preparations in 1915 was extended to *Viburnum prunifolium* and its preparations. The results of the study of *V. opulus* and *V. prunifolium* and their preparations will be published shortly.

Supervision has been made of the importation of crude drugs. The following may be cited to show some of the striking examples of adulterations detected in recently imported crude drugs: *Anethum graveolens* for dill; *Rumex* for belladonna; *Pteris aquilina* for sarsaparilla; *Lactuca* species for dandelion; *Macrotomia cephalotes* for alkanet; *Glycyrrhiza uralensis* for licorice; *Piptostegia pisonis* for jalap; *Barosma crenulata* var. *latifolia* for buchu; *Cynodon dactylon* for couch grass; Karaya gum for tragacanth; *Anthemis cotula* for chamomile; and *Ipomea orizabensis* for scammony and jalap. Of these, *Ipomea orizabensis*, *Barosma crenulata*, Karaya gum, *Macrotomia cephalotes*, *Piptostegia pisonis*, and *Glycyrrhiza uralensis* appear to have a certain value as substitutes.

Imports of ergot and areca nuts were found to be quite wormy or moldy. Orris root, nutmegs, and especially African ginger also arrived in such moldy condition that their quality was decidedly objectionable.

*Assignment.*—A. Viehoveer, C. O. Ewing.

*Proposed expenditures, 1918-19.*—\$4,185.



**Supervision of Sherley Amendment Cases:**

*Object.*—The consideration of therapeutic claims made for medicinal preparations and the supervision in the bureau of cases arising under the Sherley amendment to the food and drugs act, including assistance, when necessary, in the presentation of cases in court.

*Procedure.*—This is principally an administrative project. All cases prepared by the inspection districts arising under the Sherley amendment to the food and drugs act are considered by this office. Such administrative work as may be necessary to carry on the case to termination is conducted.

*Cooperation.*—Bureau of the Public Health Service of the Treasury Department and the Bureau of Animal Industry.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—Numerous cases were brought to trial, and nearly all were decided in favor of the Government.

*Assignment.*—M. W. Glover, detailed from the Bureau of Public Health Service of the Treasury Department, and Martin Cooley and A. J. McIntyre, of the Bureau of Chemistry.

*Proposed expenditures, 1918-19.*—\$6,200.

**Total, Drug Control, \$21,460, including \$2,425 statutory.**

**FIELD FOOD AND DRUG INSPECTION.****Inspection Work:**

*Object.*—To collect samples, inspect factories, and secure data bearing on food and drug industries.

*Cooperation.*—State food and drug inspectors and Bureau of Animal Industry inspectors.

*Location.*—District headquarters at Washington, D. C., Chicago, Ill., and San Francisco, Cal. Inspectors travel over the whole United States.

*Date begun.*—1907.

*Results.*—A large number of samples were collected during the past year, factories inspected, and data assembled and classified. Among the products to which particular attention was directed may be mentioned milk, eggs, citrus fruits, oysters, scallops, sardines, cottonseed meal, olive oil, canned tomatoes, and drugs.

Extensive campaigns have been conducted on interstate shipments of milk throughout New England and also the Middle-Western States. Extended inspection of shipments of shell eggs has been maintained throughout the country, as a result of which the quality of the shipments has greatly improved. A comprehensive survey of the citrus-fruit industry has been made, with especial reference to the prevention of shipments of immature and frozen fruit, in cooperation with city and State authorities and with the trade. Shipments of immature fruit have been reduced to a minimum. The seizures of frozen citrus fruit effected have had a deterrent effect on the traffic in this product. A large number of samples of oysters have been collected in connection with the detailed study being conducted in cooperation with Public Health Service and various State commissioners to prevent traffic in polluted and soaked oysters. Many seizures have been made of soaked scallops and shippers advised that adulteration can be prevented by washing scallops in clean salt water. The inspection of shipments of sardines, leading to court action where the products were found to be materially adulterated due to the presence of belly-blown or otherwise decomposed fish, has served to improve the quality of sardine shipments. Inspection of cottonseed mills during the past season has shown a decided decrease in the number of violations and the amounts of the deficiencies on guaranteed analyses. The inspection of tomato canneries and the collection of authentic samples have yielded data which have proved particularly valuable in repressing traffic in watered tomatoes. Fraudulent practices in the manufacture and sale of spurious drug products have been investigated and large quantities of inferior and imitation products seized.

*Assignment.*—B. R. Hart, R. E. Doolittle, R. W. Hilts.

*Proposed expenditures, 1918-19.*—\$141,050.

**Hearings and Correspondence:**

*Object.*—To hold hearings, conduct correspondence, and prepare cases at district headquarters and at stations, in connection with the enforcement of the food and drugs act as applied to both interstate and import business.

*Location.*—District headquarters at New York, Chicago, San Francisco, and stations.

*Date begun.*—1907.

*Assignment.*—B. R. Hart, R. E. Doolittle, R. W. Hilts.

*Proposed expenditures, 1918-19.*—Included in cost of laboratories listed below.

**Examination of Samples:**

*Object.*—To make chemical and other analyses of samples of foods and drugs to determine whether or not they are adulterated or misbranded.

*Location.*—District headquarters and stations of the Bureau of Chemistry.

*Date begun.*—1907.

*Assignment.*—B. R. Hart, R. E. Doolittle, R. W. Hilts.

*Proposed expenditures, 1918-19.*—Included in cost of stations listed below.

**Insecticide Work:**

*Object.*—To hold and report hearings, collect samples of both interstate and import shipments, and conduct other routine work in connection with the enforcement of the insecticide act.

*Cooperation.*—Insecticide and Fungicide Board.

*Location.*—District headquarters and stations.

*Date begun.*—1910.

*Assignment.*—B. R. Hart, R. E. Doolittle, R. W. Hilts.

*Proposed expenditures, 1918-19.*—Included in cost of stations listed below.

**Regulatory Investigations:**

*Object.*—To develop methods of analysis, detect and study new adulterants, secure data on trade practices, and study food and drug industries, in order to enforce properly the food and drugs act.

*Location.*—District headquarters and stations.

*Date begun.*—1907.

*Assignment.*—B. R. Hart, R. E. Doolittle, R. W. Hilts.

*Proposed expenditures, 1918-19.*—Included in cost of stations listed below.

**FOOD AND DRUG INSPECTION STATIONS.**

Location.	Assignment.	Proposed expenditures, 1918-19.
Eastern district: headquarters, New York, N. Y.....	B. R. Hart, chief of district.....	.....
New York, N. Y.....	A. F. Seeker.....	\$94,950
Baltimore, Md.....	A. L. Sullivan.....	19,350
Boston, Mass.....	G. H. Adams.....	18,200
Philadelphia, Pa.....	Arthur Stengel.....	14,000
Buffalo, N. Y.....	L. Patton.....	9,765
Savannah, Ga.....	.....	12,670
San Juan, Porto Rico.....	W. J. McGee.....	7,535
Central district: headquarters, Chicago, Ill.....	R. E. Doolittle, chief of district.....	.....
Chicago, Ill.....	G. W. Hoover.....	64,085
Minneapolis, Minn.....	Harry Walters.....	9,215
St. Louis, Mo.....	W. R. M. Wharton.....	12,920
Cincinnati, Ohio.....	L. B. Forst.....	12,710
New Orleans, La.....	F. L. Elliott, acting.....	11,140
Western district: headquarters, San Francisco, Cal....	R. W. Hilts, chief of district.....	.....
San Francisco, Cal.....	.....	39,070
Seattle, Wash.....	W. Vincent.....	14,330
Denver, Colo.....	R. S. Hiltner.....	17,505

**Total, Field Food and Drug Inspection, \$498,495, including \$188,420 statutory.**



## [Research.]

## FOOD INVESTIGATIONS.

**Studies on the Analysis and Composition of Vinegars:**

*Object.*—To develop methods of analysis and to acquire knowledge of the composition of vinegars.

*Procedure.*—Methods of analysis of vinegars in general are investigated and these methods applied to the determination of the composition of authentic samples of the different vinegars. For the present the work will be devoted more particularly to vinegars made from sugar or molasses and from corn-starch sugar, and will be extended later to spirit, wine, malt, and cider vinegars.

*Cooperation.*—Vinegar manufacturers.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: In 1914–15 an investigation of the composition of cider vinegar made from two tanks of apple juice holding about 25,000 gallons each was carried out and a report of the work prepared. The juice was pressed from mixed apples grown in Virginia.

During the latter part of the year 1915 an investigation of the processes used in the manufacture of so-called molasses vinegar was made and a report submitted in connection with one of the cases arising under the food and drugs act. Glycerol has been isolated in considerable quantity from cider vinegar and positively identified as such. A short paper giving the results of this work was read at the 1916 meeting of the Association of Official Agricultural Chemists and will be published later in the journal of that association. Work on the identification of the volatile reducing substances in cider vinegar was completed and the results published in the February, 1917, number of the Journal of the American Chemical Society. Work was begun in cooperation with the eastern district of the food and drug inspection service to determine the seasonal and sectional variation in the composition of fermented apple juice used in the manufacture of cider vinegar.

(2) During the fiscal year 1918 the cooperative work to determine the seasonal and sectional variation in the composition of fermented apple juice was extended so as to include the central and western districts. With the cooperation of the three districts, some 15 or more tanks of apple juice, varying in capacity from 100 to 500 barrels each, were filled and sealed at various manufacturing plants under the supervision of members of the bureau, and later, after the alcoholic fermentation had taken place, representative samples were taken and analyzed. An investigation of the effect of such quantities of volatile reducing substances as normally are found in cider vinegar upon the results obtained by the usual procedure for the determination of alcohol in such vinegar was made, and a short paper on this subject will be prepared for presentation at the 1918 meeting of the Association of Official Agricultural Chemists and possibly published in the journal of that association.

Another investigation of the changes taking place in the composition of fermented apple juice when converted into vinegar by commercial processes was carried out at Covesville, Va. This work was similar to that done in 1914–15 and was undertaken for the purpose of securing additional data of this kind.

*Assignment.*—R. W. Balcom.

*Proposed expenditures, 1918–19.*—\$5,390.

**Study of the Composition of American Oils and Fats:**

*Object.*—To determine the composition of oils and fats used in foods, in order to obtain data for standards; to improve methods of analysis; and to determine adulterants in such oils and fats.

*Procedure.*—Methods for the analysis of oils and fats are investigated and the most desirable ones applied to the analysis of authentic samples of American oils and fats.

*Cooperation.*—Manufacturers and refiners.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: Official methods have been thoroughly investigated and new methods appearing in the literature tried out and



in some cases adopted for the analysis of oils. Authentic samples of cocoa butter and its substitutes, cottonseed oil, tomato-seed oil, charlock oil, several species of the mustard family, the avocado, stillingia, okra, rice, and fevillia have been analyzed. The results upon cocoa butter, cottonseed oil, and charlock oil were published in 1916. Farmers' Bulletin 751 contains the results of some of the work on peanuts, and Separate 691 of the Department Yearbook for 1916 gives information gathered in connection with this project.

(2) During 1918: Authentic samples of the following fats, oils, and waxes were made: Cohune, palm kernel, okra seed (2), cantaloupe (2), Barre-carri, Capuassu bean, grape seed (2), soy bean (2), coruba palm, temeché palm, gipsy moth, gipsy-moth caterpillar, gipsy-moth pupae, cottonseed (10), flowering mallow, Spanish bayonet, roselle seed, nutmeg, areca, red spermoderm from peanuts, cadaver, perilla seed, Hubbard squash, pumpkin, *Aleurites trisperma*, mustard oil (6), sugar cane, candelilla, tea, and palm wax. The waxes and the okra seed, cohune, cantaloupe, flowering mallow, roselle seed, areca, and Hubbard squash oils have been more or less completely analyzed. An improved method for the determination of the hexabromid value has been devised and used in connection with the work on salmon oils and will be published as a part of that work. Samples of authentic oils made in the laboratory have been supplied to other bureaus of the department for use in connection with nutrition and other investigations. Sets of samples for use as standards have been distributed to the bureau's stations and sold to scientific investigators not connected with this department.

*Assignment.*—G. S. Jamieson.

*Proposed expenditures, 1918-19.*—\$2,945.

### **Study of the Occurrence of Heavy Metals in Natural and Manufactured Food Products and of Methods for Their Determination:**

*Object.*—To develop standard and more accurate analytical methods for the determination of heavy metals in foods and food materials, and to determine the extent of the natural occurrence of heavy metals in foods, and the sources and amounts of heavy metals found in food products ready for consumption.

*Procedure.*—Methods of analysis will be investigated and those selected or devised which give satisfactory results in the examination of the food products studied. Analyses of authentic samples will be made and processes of food preparation investigated to determine the sources of heavy metals in food products on the market.

*Cooperation.*—Manufacturers of foods and food containers.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: Methods for the determination of arsenic were investigated and details worked out for the determination of this substance in hops and in sulphur. In cooperation with the Bureau of Plant Industry, it was shown that impure sulphur was the source of the arsenic found in samples of commercial hops. Results of this work are published in Department Bulletin 568. Assistance was given in an investigation of canned-food containers by several commercial concerns, and a full share was taken in the work of preparing the report published under the title "Relative Value of Different Weights of Tin Coating on Canned Food Containers." Part was taken in the starting of an investigation on the effect of different steel bases for tin plate for canned food containers.

(2) During 1918: The presence of arsenic in dried fruits was shown to be due to the common use for sulphuring of a product containing large quantities of arsenic. It was shown that sulphur produced in the United States is free from arsenic. Therefore, with care, arsenic may be eliminated from the dried fruits. Results of this work are published in the Journal of Industrial and Engineering Chemistry for May, 1918. The general occurrence of lead in pharmaceutical zinc oxid has been investigated and the limits of sensitiveness of the U. S. P. test for lead in zinc oxid determined. It has been found that there are now two commercial sources of zinc oxid practically free from lead, while before the war none was produced in this country of the U. S. P. standard of purity. Results of this work will shortly be published. Progress has



been made in a study of the conditions of precipitation of zinc and lead by hydrogen sulphid. On account of a threatened scarcity of canned-food containers through the shortage of palm oil, considered essential for the manufacture of tin plate, the use of hydrogenated cottonseed oil as a substitute for palm oil was investigated, and it was shown that palm oil is not essential for the production of tin plate.

*Assignment.*—W. D. Collins, W. F. Clarke.

*Proposed expenditures, 1918-19.*—\$4,800.

### **Chemical Studies of Essential Oils and Natural and Synthetic Flavors and Flavoring Extracts Prepared therefrom:**

*Object.*—To devise new or to extend selected established methods of analysis, secure data as a basis for standards, and determine the composition of authentic materials.

*Procedure.*—A study is being made of the chemistry of some citrus oils and of artificial and natural oils of wintergreen and sweet birch. The composition of the flavoring substances of grapes and of cantaloupes is under investigation. A study of the behavior of some essential oils and the constituents thereof on hydrogenation is under way, as well as a study of the analysis of some synthetic flavors.

*Cooperation.*—On a limited scale with essential-oil distillers.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: An apparatus was devised for the quantitative measurement of the reaction which takes place when certain substances are catalytically hydrogenated. With this apparatus the behavior of some essential oils and of their single constituents was studied and the "hydrogen number" of certain oils determined. The results were published in the October, 1914, number of the Journal of the American Chemical Society. The acidity of vanillin on titration in aqueous alcoholic solution was determined and a method developed for the estimation of vanillin in vanilla extracts. The results of this work were published in the June, 1915, number of the Journal of Industrial and Engineering Chemistry. A method for the determination of volatile esters in lemon oils and extracts was worked out and published in the October, 1915, number of the Journal of the American Chemical Society. The flavoring material of Concord grapes was isolated in small quantities and its composition in part established. A microscopic method for the examination of methyl salicylate was developed and published in the April, 1917, number of the Journal of the American Chemical Society, and considerable progress was made in the development of methods for the analysis of wintergreen and birch oils.

(2) During 1918 the work on wintergreen and birch oils was continued and some progress made, particularly in securing additional data on the composition of authentic samples of oil of birch. This work, however, was interrupted at the end of September, 1917, owing to the resignation of the chemist to whom the project was assigned.

*Probable date of completion.*—1919.

*Assignment.*—R. W. Balcom.

*Proposed expenditures, 1918-19.*—\$2,875.

### **Investigation of the Effect of Hydrogenation upon Food Oils:**

*Object.*—To determine the nature of the changes taking place in various oils during the process of hydrogenation, with special relation to the change in the analytical constants and to the production of isomeric glycerids of the fatty acids under different known conditions; and to prepare for use in nutrition investigations, hardened oils of known history.

*Procedure.*—Authentic oils are hydrogenated under known and, as nearly as possible, commercial conditions. Samples are analyzed from time to time throughout the entire process. The exact chemical composition of the original and resulting products is determined.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: Several catalyzers were made and small amounts of cottonseed oil practically hardened with each of these, but none of them was entirely satisfactory. A new nickel catalyzer was developed which effects almost complete saturation of any refined vegetable



oil at atmospheric temperature. With this catalyzer cottonseed, peanut, avocado, corn, mustard, and other oils have been hardened.

(2) During 1918: Small quantities of peanut oil were hardened and used in making peanut-butter cakes. No work was done on the scientific investigation during the past year owing to the resignation of the assistant to whom the project was assigned.

*Probable date of completion.*—1919.

*Assignment.*—G. S. Jamieson.

*Proposed expenditures, 1918-19.*—\$1,855.

### **Investigation of the Sweating of Citrus Fruits:**

*Object.*—To investigate the methods in vogue for accelerating the coloring of green citrus fruits, and to ascertain the effect of the so-called "sweating" upon the composition, flavor, and the keeping and shipping qualities of the fruit.

*Procedure.*—Three methods of procedure will be employed: (1) Conditions of sweating as carried out by the operators at the present time will be studied, temperature and moisture conditions being noted, and analyses made of the sweat-room atmosphere and of the fruit before and after sweating. As far as the composition of the fruit is concerned, the analyses will be carried further than the usual sugar and acid determinations. An attempt will be made to determine also volatile acids and esters. Fruit in different stages of maturity from different localities and grown on different types of soil will be used. (2) Sweat rooms of one to four boxes capacity will be constructed in the laboratory and the problem studied under conditions which can be adequately controlled and where a synthetic atmosphere can be supplied. The same line of investigation will be carried on under these conditions as under the first method, outlined above. (3) The third stage of the procedure will be the storage of sweated and unsweated fruit, in order to note the effect of the sweating process upon composition and eating and keeping qualities. After the sweat rooms in the northern portion of the California citrus region have ceased operations for the season, the work will be transferred to one of the large lemon houses in the southern part of the State, where the work will be continued.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Los Angeles, Cal., and temporary stations at other points in California.

*Date begun.*—1914.

*Results.*—Preliminary studies have been made on the processes of artificially coloring oranges in central California, and the investigations have been continued in the southern part of the State on the artificial coloring of lemons. The effects of the sweating conditions upon subsequent decay and the retention of "buttons" has been investigated. Further investigation on the atmosphere of the sweat room was carried out and the effect of oversweating carefully studied.

Work on this project was temporarily suspended during the past year owing to the separation from the service of the plant physiologist who was conducting the investigations.

*Assignment.*—E. M. Chace.

*Proposed expenditures, 1918-19.*—\$3,000.

**(Study of the Composition of California Citrus Fruits:** Discontinued as a separate project; included under "Investigations of the Maturity of Fruits and Vegetables." The object of this work was to ascertain the composition of California citrus fruits with a view to establish, if possible, definite standards of maturity, and to ascertain the effect of storage at various stages of maturity upon the composition. The work on California navel oranges has been completed, and that on California grapefruit and on cantaloupes is being continued. Preliminary work has also been undertaken in Florida on both oranges and grapefruit and in California on the avocado.)

### **Study of Experimental Packs of Canned Foods:**

*Object.*—To collect information on the net weight, proper fill, and proportion of liquid and solids in canned foods; to ascertain the effect of different methods of preparation and of various types of filling machines upon the fill of the cans.



*Procedure.*—This work is carried out by preparing in commercial canneries experimental packs of canned goods of known quality under known conditions. The packs are to a large extent put up by members of the field force of the bureau, assigned by the chiefs of inspection districts and working in cooperation with the food-control laboratory. A study is made of the maximum fill of cans possible with different substances which will still permit of proper processing. In certain canned foods the addition of water is considered an adulteration, while in others the addition of excessive liquid is regarded as objectionable.

*Cooperation.*—Commercial canneries.

*Location.*—Washington, D. C., and district headquarters of the Bureau of Chemistry.

*Date begun.*—1909.

*Results.*—Results on experimental packs of a number of canned foods have led to a determination of the relative amounts of liquid and solids which cans of these articles should contain. During the season of 1918 a very extensive experimental pack of canned foods, covering practically every variety canned and every locality in which foods are put up, was prepared and is now in course of study.

*Probable date of completion.*—1921.

*Assignment.*—I. K. Phelps, H. S. Paine, and the following assigned by chiefs of inspection districts: C. O. Dodge, H. C. Kitchen, and R. S. Hollingshead, together with assistants detailed to handle certain phases of the work.

*Proposed expenditures, 1918-19.*—\$8,000.

**(Investigation of Canning Processes and Methods:** Discontinued as a separate project. Further work along this line will be done under "study of Experimental Packs of Canned Foods." A study of the packing of corn and the effect of the addition of starch to this product was made. Italian and domestic tomato products were studied with reference to the enforcement of requirements as to cleanliness of these products. The composition of blighted tomatoes was also investigated.)

#### **Study of Methods of Preparing Egg Oil from "Off-Grade" Eggs:**

*Object.*—To devise a cheap and efficient means for the separation of the oil and leather-tanning constituents from this class of eggs, and to encourage the use of this oil in the leather tanning industry, thereby affording a ready and suitable market for eggs of a quality unsuitable for food purposes.

*Procedure.*—Preliminary work will be done in the laboratory at Washington, and ultimately a field laboratory will be established at some point in the egg-breaking centers to work out methods and their application to the separation of oil and lecithin from waste eggs.

*Cooperation.*—Egg-breaking firms and tanneries.

*Location.*—Headquarters, Washington, D. C.

*Date begun.*—1913.

*Results.*—A sufficient quantity of laboratory prepared oils for testing on a small scale was sent to a commercial tanner, who reported satisfactory results with them when used on certain kinds of leather. The opinion was expressed that such oil could be satisfactorily used to increase the oil content of low-grade yolks.

*Probable date of completion.*—1920.

*Assignment.*—H. W. Houghton.

*Proposed expenditures, 1918-19.*—\$2,285.

#### **Study of Wheat and Wheat Flour with Reference to the Effects of Commercial Bleaching Processes:**

*Object.*—To study the effects of aging and bleaching processes on the properties of flour as evidenced by the products (bread, etc.) made from flour; to study chemical processes to detect bleaching, etc.

*Procedure.*—Studies are made of flours of various ages, kinds, and grades, both unbleached and bleached, when made into bread, etc., under domestic, laboratory, and commercial conditions.

*Cooperation.*—Flour warehousemen, millers, and bakers.

*Location.*—Washington, D. C.

*Date begun.*—1915.



*Results.*—Special investigations have been conducted in regard to the effects produced by the bleaching of flour with nitrogen oxids. These results are being assembled.

*Probable date of completion.*—1919.

*Assignment.*—I. K. Phelps, B. R. Jacobs, E. E. Smith.

*Proposed expenditures, 1918-19.*—\$1,025.

**(Investigation of the Manufacture and Composition of Sauerkraut and Pickles: Transferred to subgroup "Microbiological Investigations.")**

**Study of Poisonous Elements on Fruits and Vegetables Sprayed with Poisonous Sprays:**

*Object.*—To determine what quantity of poisonous elements remain on fruits and vegetables sprayed with poisonous sprays; to ascertain whether such poisonous elements can be removed by the consumer, and how to determine the quantity of poisonous elements that may be present by reason of the excessive use of sprays; and to find out whether changes can be made in the time and method of spraying whereby the danger from injurious metals may be lessened.

*Procedure.*—Various kinds of fruit trees and vegetables are sprayed according to the accepted schedules and a study made of the composition of the fruits as they reach the consumer. Fruits and vegetables are treated in various ways to see whether poisonous metals can be removed. Excessive amounts of insecticides and fungicides are sprayed in order to determine how much of the injurious metals may be present under adverse conditions, and methods of so changing the usually accepted spraying schedules as to lessen or eliminate danger from the poisonous elements are studied.

*Cooperation.*—All the analytical work is performed at headquarters. The spraying is done at the Arlington Farm, on rented trees, if necessary, and at various orchards throughout the United States, where agents of the department are carrying on experimental work. It is planned to make this a cooperative study by the Bureaus of Chemistry, Plant Industry, and Entomology. It is possible that some of the State experiment stations also will be asked to aid in the work by spraying lots of trees in accordance with definite instructions and by sending the fruit to Washington for examination.

*Location.*—Washington, D. C., Arlington Farm, Va., and orchards in various parts of the United States.

*Date begun.*—1915.

*Results.*—A large amount of analytical data has been obtained during the past three years. The results can not be judged, however, until this information has been collated at the end of the investigation.

*Probable date of completion.*—1920.

*Assignment.*—W. D. Lynch, J. K. Haywood, C. C. McDonnell.

*Proposed expenditures, 1918-19.*—\$2,575.

**Investigation of Color Substances, with Special Reference to Food and Drug Products:**

*Object.*—To investigate the formation and methods for detection, isolation, comparison, and determination of structure of color substances, both natural and artificial, used in food and drug products.

As applied to agricultural research, this investigation is designed to include the study of various compounds synthesized by plants with special reference to their detection and to the investigation of their properties, structure, identification, and synthesis.

*Procedure.*—Various pure substances, largely of an organic nature, are prepared from plants or plant products or synthesized and a study of their chemical and physical properties made.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: Methods have been developed for the separation, estimation, and identification of a number of synthetic colors used in fats and oils and some other food products, including butter, oleo-margarine, and alcoholic preparations.

The investigation of the natural coloring substances of a number of food products was begun, including studies of chlorophyll, xanthophyll,



and carotin and also the natural coloring substances of a number of vegetable oils.

A number of dyes were synthesized and prepared in a pure condition for study as to toxicity in cooperation with the pharmacological laboratory.

(2) During 1918: The investigation of oil-soluble colors used in food products has been completed, the results being published in the June issue of the Journal of Industrial and Engineering Chemistry under the title "Detection of Added Color in Butter or Oleomargarine."

An investigation of chlorophyll has been partially completed. Methods of isolation of a large number of coloring substances in leaf green have been developed, and an article descriptive of the same is now in course of preparation.

*Assignment.*—H. D. Gibbs.

*Proposed expenditures, 1918-19.*—\$2,000.

**(Study of Vanilla and Tonka Beans and Their Extracts:** Project discontinued. No work was done on this project during the fiscal year 1918.)

**(Investigation of Enameled Cooking Utensils:** Project discontinued. No work was done on this project during the fiscal year 1918.)

### **Study of Green and Roasted Coffee:**

*Object.*—To investigate the changes which take place in coffee upon roasting, secure information on the moisture content of green and roasted coffee and changes in moisture in storage, study the glazing or coating of coffee, investigate the commercial grades of coffee, and secure data for establishing a standard for coffee imported into this country.

*Procedure.*—Commercial practices in grading and roasting coffees are studied, including the collection and analysis of samples. Authentic samples of coffee are obtained from Brazil and examined for black and spoiled beans, overripe, shriveled, and immature beans, and for bean shells and foreign matter. Further work is contemplated on the determination of moisture in roasted coffee and on the chemical and physical study of specific forms of objectionable constituents of commercial coffee.

*Cooperation.*—State Department and manufacturers.

*Location.*—Washington, D. C., New York, Maryland, Pennsylvania, Missouri, and Louisiana.

*Date begun.*—1915.

*Results.*—No work was done on this project during the fiscal year 1918.

Preliminary reports on coating and grading of coffees were submitted at the beginning of this work. A number of samples of coffee were graded and examined with the view of studying the relation of grade to objectionable material present. Chemical analyses were made on both green and roasted coffees.

*Probable date of completion.*—1922.

*Assignment.*—I. K. Phelps, A. Viehoveer.

*Proposed expenditures, 1918-19.*—\$1,510.

### **Study of Gelatin:**

*Object.*—To study the chemical composition, methods of manufacture, and uses and requirements of gelatin for foods and its differentiation from gelatin for industrial purposes.

*Procedure.*—The service which gelatin performs in food mixture is ascertained and experiments made in cooperation with users in order to find out their needs. The relation of gelatin to the parent substance ossein of bones is being studied and an investigation made of the yield and practicable improvement in the output and quality of gelatin as adapted to the requirements for food and industrial uses. A study is being made of the optical and other properties of gelatin in order to better understand its chemical nature, to estimate and standardize it as to strength and purity, and to detect and determine it in mixtures.

*Cooperation.*—Bureau of Animal Industry.

*Location.*—Washington, D. C.

*Date begun.*—1916.

*Results.*—(1) Prior to 1918: A study of the rotatory power of gelatin has been made.



(2) During 1918: A paper on the "Mutarotation of Gelatin and Its Signification in Gelatin" was prepared and much progress made in the development of a new method for testing the jelly strength of gelatin.

*Assignment.*—C. R. Smith.

*Proposed expenditures, 1918-19.*—\$2,925.

**(Maturity Test for Muskmelons:** Discontinued as a separate project; included under the general project, "Investigations of the Maturity of Fruits and Vegetables.")

**(Detection of Commercial Acetic Acid in Catsup by Means of the Formic-Acid Determination:** Project completed. Work on this project was begun during the fiscal year 1917. Samples of the various grades of acetic acid manufactured in this country were obtained and the amount of formic acid in the samples determined.)

**(Study of a Method for Determining Volatile Amines in the Presence of Ammonia:** Project completed. The object of the investigation was to find a method for detecting volatile amines in foods. A specific test has been found which shows the presence of volatile amines whether or not ammonia is also present. A reagent was also found that gives a test for tertiary amines in the presence of other amines or of ammonia.)

**Investigations of Wheat, Barley, Rice, Flour, and Prepared Cereal Products:**

*Object.*—To determine (a) the methods for the valuation of wheat, barley, rice, flour, bread, macaroni, etc.; (b) the effect of various factors on the quality of flour and prepared products; and (c) the composition of wheat, flour, bread, breakfast foods, and macaroni; and to obtain data which may be useful in connection with the manufacture of macaroni, pearled barley, natural brown rice, and flour containing a large portion of the wheat.

*Procedure.*—Mill products of wheat and other cereals obtained in commercial mills and in the bureau's experimental mill are analyzed, in order to determine the character of the products from each process. The flour made by milling is baked. Other wheat products, such as macaroni and breakfast foods, also are analyzed, in order to obtain knowledge regarding their characteristics. In order to obtain information regarding the best class of wheat used in the production of semolina for the purpose of making macaroni, the quality of the semolina and of the macaroni produced therefrom abroad and in this country will be compared.

*Cooperation.*—Bureau of Plant Industry and Bureau of Markets.

*Location.*—Washington, D. C.

*Date begun.*—1909.

*Results.*—(1) Prior to 1918: In Bureau of Chemistry Bulletin 164, "Graham Flour," the condition of the trade regarding whole-wheat and graham flour was shown. This study has likewise resulted in the elaboration of a method for distinguishing graham flour from so-called, or misbranded, graham flours. An article entitled "A Report of the Chemical and Bacteriological Study of Wrapped Bread," showing that wrapped bread will keep fresh for at least 72 hours, was published in the American Journal of Public Health, vol. 4, No. 9.

Much work has been done with milling wheat, but these data have not yet been assembled. The results obtained, however, show the relation between the composition of wheat and flour made therefrom and the difference in composition between the products of the various break and smooth rolls.

Granulation experiments have been carried on with commercial flours and with flours made in the laboratory. The results show that the commercial flours are ground to a greater degree of fineness than is suspected and that the finest product, namely, that portion which goes through the No. 25 sieve, is appreciably inferior in bread-making value to the intermediate portions.

(2) During 1918: A study of the milling and baking quality of the rarer wheats—einkorn, emmer, spelt, and Polish wheat—was made. The results show that emmer and spelt (free from hulls) and Polish wheat can be milled into a satisfactory flour and the flour used in making a good loaf of bread.

A study of the process of pearling barley was made. The results obtained were presented to the American Chemical Society meeting in Boston in August, 1917.



*Assignment.*—J. A. Le Clerc, L. H. Bailey, C. D. Garby, P. L. Mann.

*Proposed expenditures, 1918-19.*—\$2,060.

### **Studies of the Composition and Utilization of the Soy Bean and Its Products:**

*Object.*—To obtain information regarding the composition of soy beans and the chemical changes which take place in the preparation of their products.

*Procedure.*—Soy beans grown in different parts of the country by the Bureau of Plant Industry are analyzed, especially for fat and protein. Those varieties rich in fat and protein are to be used in investigations to determine which are best suited for the manufacture of various soy-bean products.

*Cooperation.*—Office of Forage-Crop Investigations, Bureau of Plant Industry.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: About 500 samples of soy beans grown in a number of localities and representing approximately a score of varieties were analyzed, and the results as given in a paper presented before the Society of Agronomy show that high protein soy beans are low in fat, that high fat soy beans are low in protein, that the average fat content is about 18 per cent and the average protein content almost 40 per cent, and that environment plays the predominant part in influencing the composition of soy beans.

(2) During 1918: Soy beans representing a score of varieties, each grown in a dozen or more localities, are being analyzed.

*Assignment.*—J. A. Le Clerc.

*Proposed expenditures, 1918-19.*—\$980.

### **Standards for Peanut Products:**

*Object.*—To determine reasonable standards for peanut products; also to prepare definitions of such standards to be used in the enforcement of the food and drugs act.

*Procedure.*—Methods of preparing peanut products are to be studied at various mills in the Southern States. Samples of known origin will be examined, attempts being made to obtain samples prepared under normal as well as ideal factory conditions. On the basis of such examinations chemical and microscopic standards will be suggested.

*Cooperation.*—Various mills will be visited and processes studied.

*Location.*—Washington, D. C., and peanut-growing sections.

*Date begun.*—1918.

*Assignment.*—J. B. Reed, G. L. Bidwell, J. K. Haywood.

*Proposed expenditures, 1918-19.*—\$2,050.

### **Investigations of Butter and Cream:**

*Object.*—To develop methods for the examination of butter and cream in connection with the enforcement of the food and drugs act.

*Procedure.*—Experimental samples are produced under known conditions and the results checked against commercial products.

*Cooperation.*—Bureau of Animal Industry, Indiana Agricultural Experiment Station, food-control officials, and dairy organizations.

*Location.*—Washington, D. C., and field laboratories temporarily located where material can be obtained.

*Date begun.*—1918.

*Assignment.*—H. W. Redfield.

*Proposed expenditures, 1918-19.*—\$3,920.

### **Investigation of Fruit Juices, Fruit Sirups, and Crushed Fruit:**

*Object.*—To investigate the commercial methods of preparing and handling fruit juices, fruit sirups, and crushed fruit, and to determine the composition of these products, in order to secure information needed in connection with the enforcement of the food and drugs act.

*Procedure.*—Manufacturers will be visited, observations made of the processes employed, and samples analyzed. The investigation will be extended sufficiently to take into account variations in composition which are due to differences in climate, variety of fruit, etc.

*Cooperation.*—Manufacturers.

*Date begun.*—1918.

*Probable date of completion.*—1920.

*Assignment.*—H. S. Paine, J. I. Palmore.

*Proposed expenditures, 1918-19.*—\$3,455.

### **Study of Egg and Egg-White Substitutes:**

*Object.*—To procure data regarding the composition and use of egg and egg-white substitutes for use in connection with the enforcement of the food and drugs act.

*Procedure.*—Samples of egg and egg-white substitutes, substitute shortening materials, and so-called flour improvers will be collected and their composition and the effect they have on the baking qualities of flour determined. Statements will be obtained from bakers and confectioners using these articles as to the purpose for which they are used and the claims made for them by manufacturers.

*Location.*—Washington, D. C.

*Date begun.*—1918.

*Assignment.*—I. K. Phelps, B. R. Jacobs, E. E. Smith.

*Proposed expenditures, 1918-19.*—\$1,310.

### **Application of Crystallography to Chemical Analysis of Food and Drugs:**

*Object.*—The development of methods for the analysis of food and drug products by crystallographic methods.

*Procedure.*—The characteristics of the crystal forms of compounds found in food and drug products are studied and the results thus obtained applied for the rapid determination of such compounds.

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Results.*—The following publications outline some of the results obtained:

“Application of Optical Methods of Identification of Alkaloids and Other Organic Compounds,” Department Bulletin 679; “Certain Relations Between the Refractive Indices and Crystal Axial Ratios in Organic Compounds,” Journal of the Washington Academy of Sciences, vol. 8, No. 9; “Modern Extension of Haüy’s Laws of Crystallography,” Proceedings of the New York Mineralogical Club, American Mineralogist, vol. 3, No. 6; “Identification of the Cinchona Alkaloids by Optical Crystallographic Measurements,” Journal of the American Chemical Society, vol. 40, No. 7; “Crystallography: The Assignment of Crystals to Symmetry Classes,” Journal of the Washington Academy of Sciences, vol. 8, No. 14.

*Assignment.*—E. T. Wherry.

*Proposed expenditures, 1918-19.*—\$2,800.

### **Investigation of Analytical Methods:**

*Object.*—To investigate the methods used in food and drug analysis with a view to their improvement, and to devise new methods.

*Procedure.*—A critical study is being made of certain methods of analysis of food and drug products which at present are not satisfactory. New methods will be devised and put into application in such cases whenever practicable.

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Results.*—A paper entitled “Determination of Arsenic in Insecticides” has been published in the Journal of Industrial and Engineering Chemistry, April, 1918, vol. 10, No. 4. This describes a new method for the determination of arsenic in insecticides which is shorter and simpler than the method previously used and gives very accurate results.

The following papers have been prepared for publication in technical journals:

“Gravimetric and Volumetric Determination of Zinc Precipitated as Zinc Mercuric Thiocyanate,” which describes a general method for the determination of zinc, particularly in insecticides and alloys. The method is in use in the Bureau of Chemistry at the present time and has proved very satisfactory.

“Determination of Copper in Insecticides.” This is an application of the determination of copper by potassium iodate, and is especially adapted for use in the analysis of insecticides. It is simpler and shorter than the electrolytic methods heretofore used.



"Gravimetric and Volumetric Determination of Mercury Precipitated as Mercury Zinc Thiocyanate." This paper describes two methods for the determination of mercury and is especially adapted for the analysis of drug products.

*Assignment.*—G. S. Jamieson.

*Proposed expenditures, 1918-19.*—\$3,100.

**Total, Food Investigations, \$60,860.**

#### · NET-WEIGHT INVESTIGATIONS.

##### **Tolerances on the Weight of Package Foods:**

*Object.*—Collection and analysis of information relative to the unavoidable discrepancies in the weight of package foods and assistance in the enforcement of the net-weight amendment to the food and drugs act.

*Procedure.*—Field weighings will be made under various specified conditions and the resulting data compiled.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—Work on butter, cheese, condensed milk, and a class of products designated as "granular-free flowing materials" has been completed.

Circular 95 of the Office of the Secretary, describing methods of good commercial practice in weighing print butter, has been published. Important information has been distributed to the field force of the bureau concerning flour and other products.

*Assignment.*—H. Runkel.

*Proposed expenditures, 1918-19.*—\$3,800, including \$1,200 statutory.

#### PHYSICOCHEMICAL INVESTIGATIONS.

##### **Physicochemistry and Engineering of Carbonation:**

*Object.*—To determine the physical and chemical characteristics of carbonated liquids; to ascertain the machinery processes which produce given carbonation effects.

*Procedure.*—An experimental study is made of carbonated liquids prepared under known laboratory conditions and of carbonated liquids sold in trade, supplemented by factory study.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: Using the carbonation machine developed during this investigation, a systematic study of the effect of various constituents of malt, vinous, and soft drinks has been made. A number of carbonated liquids, both natural and artificial, have been studied. The results obtained are used in the regulation of imports and of domestic commerce in foaming wines, cider, etc. The results also bear upon the use of distilled water in manufacturing carbonated nonalcoholic drinks. A patent (U. S. Patent No. 1,216,722) has been granted on the carbonating machine developed in this investigation.

Some of the results of the work appear in two published papers entitled "Carbonation Studies: I. A Mechanical Stirrer for Carbonation Direct in the Bottle" and "Carbonation Studies: II. The Carbonation of Distilled Water." Other papers, including a theoretical treatment of the statics and dynamics of the subject, are in course of preparation.

(2) During 1918: Regulation work and consultation and factory inspection have been done.

*Assignment.*—H. E. Patten.

*Proposed expenditures, 1918-19.*—\$1,400.

##### **Electrochemical Study of the Reactions of Vegetable, Fruit, and Animal Juices:**

*Object.*—To make an electrochemical study of reactions in vegetable, fruit, and animal juices, involving an evaluation of the so-called hydrogen-ion concentration; to study the causes of corrosion of metallic containers; to secure a better understanding of jell formation; and to obtain better preservation of food products.

*Procedure.*—Necessary physical, electrical, and chemical apparatus of a fixed nature is assembled to carry out electromotive force determinations and electrical conductivity determinations under controlled conditions.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: An air thermostat has been installed. A large water thermostat for use with the electrochemical conductivity set and for solubility determinations has been completed.

The electromotive force of hydrogen has been measured against various fruit juices and the hydrogen-ion concentration calculated therefrom.

An extended study under more accurately controlled conditions has been made on grapefruit and on oranges to ascertain how their effective free acidity varies with approach to maturity. The purpose here is to secure a test of ripeness or sourness which shall be independent of personal differences in taste.

Similar application to maturity studies on other fruits is contemplated. A study was made of cantaloupes from the Imperial Valley to ascertain the relationship between the hydrogen-ion concentration of the juice and the degree of maturity. Determinations have been made on the free acidity of a series of canned goods in connection with investigations of the Technical Committee on Tin Plate.

(2) During 1918: A series of measurements was partly completed dealing with the effect of suspended particles upon the electrical conductance and upon the hydrogen-ion concentration and the concentration of electrolyte. A special conductivity cell has been devised for this work.

*Assignment.*—H. E. Patten, T. O. Kellems.

*Proposed expenditures, 1918-19.*—\$1,300.

### **Physical Chemical Study of the Reactions of Vegetable, Fruit, and Animal Juices:**

*Object.*—To determine what effect the concentration of individual chemical substances in plant and animal juices has on the keeping qualities of food products; also to determine the chemical conditions which induce jell formation.

*Procedure.*—An investigation is being made of the concentration of individual chemical substances in plant and animal juices in their relation to the neutral point between acidity and alkalinity. The conditions of jell formation and the colloid chemistry involved is studied.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: Preliminary work on the effect of concentration of sugar upon the free acidity in fruit juice has been done. A special viscosimeter is being designed to give the approach of a concentrated juice to jell structure. An improved form of automatic mercury purifier and a special electrical vacuum still for mercury have been built. A paper has been published in the Journal of Industrial and Engineering Chemistry entitled "An Apparatus for the Purification of Mercury."

(2) During 1918: A paper entitled "A Study of the Electrical Conductance of the Aqueous Phthalate Solutions" was published. Preliminary work on the effect of hydrogen-ion concentration upon the setting of gelatin is under way.

*Assignment.*—H. E. Patten, T. O. Kellems.

*Proposed expenditures, 1918-19.*—\$1,300.

### **Chemistry and Manufacture of Baking Powders:**

*Object.*—To determine the effect of various constituents of baking powders upon their baking efficiency; to study the occurrence of impurities detrimental to health and the analytical methods of estimating them.

*Procedure.*—This investigation involves the application of equilibria and rate of reaction methods to the chemistry of baking powders.

*Location.*—Washington, D. C.

*Date begun.*—1911.

*Cooperation.*—Food manufacturers, chemists engaged in food control, university research chemists, and Association of Official Agricultural Chemists.

*Results.*—(1) Prior to 1918: A synthetic study of the effect of calcium sulphate in phosphate baking powders has been carried out and a report made. A study of the determination of lead in baking powders has been made. A report has been prepared giving the results of a study of acidity of baking-powder materials. Papers bearing on this subject have been



prepared as follows: "The Rôle of Calcium Sulphate in Phosphate Baking Powders" and "Report on Baking Powders." There is in progress a study of the determination of lead in baking powders. A report has been submitted for 1917 to be published in Journal of the Association of Official Agricultural Chemists.

(2) During 1918: A collaborative study on the determination of lead and fluorin in baking powder was in progress, and factory visits were made in connection with the investigation.

*Assignment.*—H. E. Patten.

*Proposed expenditures, 1918-19.*—\$1,300.

**Total, Physicochemical Investigations, \$5,300, including \$300 statutory.**

#### MICROBIOLOGICAL INVESTIGATIONS.

##### Cultural Studies of *Penicillium* and *Aspergillus* and Species of Related Genera:

*Object.*—To identify species of these genera and to study their morphology and physiology and their distribution in nature, with a view to determine which of these species are active in the spoilage of foodstuffs.

*Procedure.*—Cultures of these organisms from any source are made, especially where found to be factors in the decomposition or fermentation of food and drugs. A comparative study is being made of species and of their physiological activities in their natural substrata.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—The following articles have been published: "Effect of Pasteurization on Mold Spores," Journal of Agricultural Research, vol. 6, No. 4; "*Penicillium Avellaneum*, a New Ascus-Producing Species," Mycologia, vol. 7, No. 5; and "An Oxalic-Acid Producing *Penicillium*," Journal of Biological Chemistry, vol. 22, No. 2.

The collection of data covering the typical mold floras of spoilage in foods has been continued as rapidly as material could be obtained. A paper entitled "*Aspergillus Fumigatus*, *A. Nidulans*, *A. Terreus* n. sp. and Their Allies" has been published in the American Journal of Botany, vol. 5, No. 2.

*Assignment.*—Charles Thom.

*Proposed expenditures, 1918-19.*—\$2,310.

##### Mycology of Spoilage in Cereal Products:

*Object.*—To determine the cause of deterioration of the common cereals and their manufactured products, with special reference to the part played by microorganisms in such spoilage.

*Procedure.*—Cultures are obtained from such products in varying stages of deterioration as the basis for identifying significant species. These are inoculated into cereals for further study.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: A study of the deterioration of oats, together with an investigation of methods for the chemical detection of the products of incipient decomposition, has been conducted.

(2) During 1918: Attention was primarily given to problems of spoilage in soft corn and immature beans. Laboratory experiments to determine the relation of microorganisms to these losses and methods of controlling the losses were undertaken. The definite relation between the amount of water present in the product and the steps necessary for preservation was determined. A close adjustment between the occurrence of certain types of molds and the presence of particular percentages of water in the corn was clearly demonstrated.

*Assignment.*—Charles Thom.

*Proposed expenditures, 1918-19.*—\$1,125.

##### Biological Factors in the Deterioration of Forage and Feeding Stuffs:

*Object.*—To isolate and identify organisms concerned in the specific forms of spoilage of the food of domestic animals, and to determine the conditions favorable to the activities of such species.

*Procedure.*—Cultures are made from feed in various stages of decomposition. The organisms are isolated, compared, and described, and pure-

culture inoculations made for the purpose of studying their relations to decomposition processes.

*Cooperation.*—The Pathological Division of the Bureau of Animal Industry studies the relation of such feeding stuffs to animal health and nutrition.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—The work upon *Bacillus botulinus* in connection with the study of moldy feeding stuffs has been recommended for publication.

During the past year work under this project was confined to the examination of miscellaneous samples of feeding stuffs, with special attention to products of a highly concentrated nature. The close relationship between certain organisms and the spoilage of this group of feeding stuffs has been determined.

*Assignment.*—Charles Thom.

*Proposed expenditures, 1918-19.*—\$555.

#### **Classification of the Bacteria Occurring in Food Products:**

*Object.*—To determine the characteristic normal and pathological flora of the various food products met with in inspection work and food research problems.

*Procedure.*—Characteristic organisms present in each particular form of food are isolated and identified by standard methods.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: The floras of sauerkraut, corn silage, pickles, canned sardines, and condensed milk have been studied.

(2) During 1918: The organisms of vinegar fermentation, salt-tolerant organisms, and miscellaneous organisms from many foodstuffs were worked out.

*Assignment.*—Edwin Le Fevre.

*Proposed expenditures, 1918-19.*—\$2,250.

#### **Toxicity of Rhizopus and Other Mucorineæ as a Factor in Food Spoilage and Intoxication by Spoiled Food:**

*Object.*—To obtain information in regard to the effect of spoilage of food.

*Procedure.*—Pure mold cultures are grown in large quantity and examined pharmacologically. An attempt is made to isolate and identify the toxic substance produced by the growing mold.

*Cooperation.*—Carnegie Institution of Washington at Cold Spring Harbor, N. Y.

*Location.*—Cold Spring Harbor, N. Y. (mold growing); Washington, D. C. (chemical and pharmacological work).

*Date begun.*—1915.

*Results.*—The best period of growth for the production of maximum toxicity by the growing mold has been ascertained. Large quantities of the mold material, dried and ground, have been produced. The chemical work on the dried mold powder has shown that the reagents used in protein precipitation will precipitate the toxic principle. So far no chemical individual has been obtained sufficiently pure to permit identification. It is expected to publish the results so far obtained and to continue the chemical work at a later date with the material now on hand.

*Assignment.*—A. F. Blakslee, Cold Spring Harbor, N. Y.; J. F. Brewster, Washington, D. C.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

**(Soaking of Oysters:** Discontinued as a separate project. Additional work will be done under "Field Food and Drug Inspection." A number of successful prosecutions were brought under the food and drugs act based on the results secured under this project.)

#### **Study of Swelled Canned Foods:**

*Object.*—To determine the types of microorganisms responsible for the spoilage and "swells" in canned food products, and also the gaseous products of their growth, as an aid in the differentiation of the various forms of spoilage.



*Procedure.*—Spoiled canned foods are collected and the gases and organisms found in them determined. From information thus gathered spoiled canned products are prepared and the gaseous products formed in the cans under these known conditions determined.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: Work under this project has so far been confined to the examination of swelled cans of sardines. An anærobic, spore-bearing, gas-forming organism, not yet positively identified, has been isolated and is believed to be responsible for the greater part of the swelling of cans of sardines. Apparatus for obtaining the gas from swelled cans has been assembled and is in working condition.

(2) During 1918: Further work has resulted in the development of a method for the separation and determination of the substance composing the total volatile alkaline material derived from such products. A manuscript entitled "A Method for the Separation and Quantitative Determination of the Lower Alkylamines in the Presence of Ammonia" has been prepared for publication. In the study of swelled cans of sardines two organisms were isolated. One of them is probably identical with Wielsen's *Bacillus Walfishrauschbrand*. Both organisms are anærobic spore-bearers, form gas, and produce ammonia and amines in large quantities when grown upon a medium containing fish protein. The amine fraction was found to be composed in greater part of triamine.

*Assignment.*—F. C. Weber, J. B. Wilson.

*Proposed expenditures, 1918-19.*—\$1,325.

(Investigation of the Cleansing of Oysters: See statement under "Oyster and Other Shellfish Investigations.")

#### Chemical Investigations of Phenols Produced by Growing Molds:

*Object.*—To isolate and determine the chemical nature of phenols produced by growing molds; to study from the viewpoint of food spoilage the effect of such phenols upon the animal body when taken with food.

*Procedure.*—The molds are allowed to grow upon suitable media and are examined from time to time to determine the optimum conditions of growth for the production of phenols. The phenol is then isolated, when possible, by appropriate methods, purified, analyzed, and its physiological action studied by experiments on animals.

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Results.*—The mold *Aspergillus niger*, occurring on imported figs, was examined and found to give the usual chemical tests for phenols. The phenol occurs in the vegetative growth of the mold itself and is extracted by alcohol. A sufficient amount of the reaction-giving substance is being collected for study. Several strains of molds occurring on food-stuffs and in the soil (one of which was identified as *Aspergillus terreus*, the others appearing closely related) gave identical color tests for phenols. A chemical method for classification is thus suggested. Various other species of molds were tested for phenols.

*Assignment.*—C. L. Alsberg, J. F. Brewster.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

#### Comparative Study of the Floras on Spoiled Canned Foods:

*Object.*—To ascertain the kinds and classification of organisms found in spoiled canned-food products.

*Procedure.*—Laboratory examination and classification of the various floras found will be made.

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Results.*—The work under this project has included the examination of cans of spoiled food submitted to this bureau from different offices of the department and the study of the toxin-producing group commonly known as *Bacillus botulinus*. The organisms encountered in the spoiled product have been carefully isolated and studied. Correlation between the source and type of flora in canned foods has been made wherever



possible and the information furnished to those interested in the product. All strains of the toxin-forming group known in America or believed to belong to this group have been brought together, and comparative studies of their activities are being made as rapidly as other work will permit.

*Assignment.*—Chemist to be appointed.

*Proposed expenditures, 1918-19.*—\$500.

### **Manufacture and Composition of Sauerkraut and Pickles.**

*Object.*—To study the normal, as well as abnormal, fermentation of sauerkraut and pickles and methods of overcoming losses from various causes; and to determine the normal composition of good kraut, the proper fill of canned kraut, the use of pure cultures in its manufacture, and the utilization of waste products.

*Procedure.*—Laboratory experimentation and field investigations are made at the proper seasons.

*Cooperation.*—Manufacturers.

*Location.*—Washington, D. C., and field laboratories to be established, where necessary.

*Date begun.*—1915.

*Results.*—Studies of sauerkraut began during the season of 1915 and have involved the inspection of sauerkraut factories and laboratory work in following the fermentation from the beginning to the completed product. The organisms concerned in sauerkraut fermentation have been brought together and studied.

The following papers have been published: "Bacteriology of Sauerkraut," abstract in proceedings of the Society of American Bacteriologists and in the Journal of Bacteriology, vol. 1, No. 1, 1916; "Fermentation of Sauerkraut," American Grocer, vol. 95, No. 7, February, 1916, and in The Canner and Dried Fruit Packer, convention number, February, 1916; "The Sauerkraut Industry of the United States," The Canner, vol. 44, No. 15-17, 1917; and "Further Studies on the Fermentation of Sauerkraut," Abstracts of Bacteriology, vol. I, No. 1, February, 1917. A paper entitled "Fermentation of Sauerkraut" was read before the kraut section of the National Canners' Association annual meeting, Cleveland, Ohio, February 7-11, 1917, and was published in abstract in The Canner, February, 1917.

*Assignment.*—Charles Thom.

*Proposed expenditures, 1918-19.*—\$3,375.

**Total, Microbiological Investigations, \$11,440, including \$1,735 statutory.**

### **MICROCHEMICAL INVESTIGATIONS.**

#### **Microanalysis of Foods and Drugs:**

*Object.*—To develop microscopical methods of analysis of food and drug products.

*Procedure.*—Field and laboratory studies are conducted as each problem demands.

*Location.*—Headquarters, Washington, D. C.

*Date begun.*—1901.

*Results.*—(1) Prior to 1918: Important results were obtained in connection with studies in the detection of pepper shells in ground pepper, estimation of the percentage of hulls in cottonseed meal, detection of artificial coloring in teas, manufacture of pork and beans for the purpose of detecting decomposed beans in the finished product, malt-sprout manufacture, nature of the decomposition of various fruits and vegetables and development of methods for its detection, and estimation of ergot in rye flour. An investigation of the tomato-sauce industry of Italy was undertaken and studies made of currant-packing conditions in Greece, the egg breaking and drying industry of the United States, the microchemistry of alkaloids, the microscopy of American honeys, and the microscopy of commercial nuts.

Publications issued: Bureau of Chemistry Bulletins—66, "Fruits and Fruit Products"; 94, "Studies on Apples"; 100, "Some Forms of Food Adulteration"; 108, "Commercial Feeding Stuffs of the United States";



110, "Chemical Analysis and Composition of American Honeys"; 117, "Commercial Sicilian Sumac," and 160, "A Study of Nuts with Special Reference to Microscopic Identification"; Department Yearbook articles "The Use of the Microscope in the Detection of Food Adulteration" (1907) and "Decomposition and Its Microscopical Detection in Some Food Products" (1911); an article entitled "Tannin Cells of Persimmons," Bulletin of the Torrey Botanical Club, 1906, and a paper entitled "A Method for the Detection of Color in Tea," reprinted from the Original Communications, Eighth International Congress of Applied Chemistry, vol. 18, page 301.

(2) During 1918: The studies upon the microscopy of flours have shown a general correlation between the degree of purity as regards amount of offal and the microscopic count obtained. Studies have also been conducted to determine the reliability and significance of quantitative microscopical methods for the determination of ingredients in mixtures, such as cocoa shells in cocoa products and mixtures of starches. Preliminary investigations have been begun upon the subject of apple waste in evaporators and the detection of decay in products made therefrom.

*Assignment.*—B. J. Howard.

*Proposed expenditures, 1918-19.*—\$6,040.

#### **Studies in the Microscopical Detection of Decomposition in Tomato Products:**

*Object.*—To determine the influence of certain processes of manufacture upon the physical and microscopical characteristics of tomato products, special attention being given to the influence of the finishing process upon the microscopical count, the correlation between the amount of decay in tomatoes and the count on the finished product, and the influence of various factory operations and technique upon the character of the final product.

*Procedure.*—Studies are made under factory and laboratory conditions of various questions involved in the making of tomato products and of the influence of various conditions upon the character of the product. In cooperation with manufacturers, assistance is rendered in maintaining control over the sanitary character of the product.

*Cooperation.*—Tomato-canning establishments.

*Location.*—Headquarters, Washington, D. C.; various canneries located in the tomato-producing sections of the United States.

*Date begun.*—1908.

*Results.*—(1) Prior to 1918: A better understanding of the causes of high bacterial counts in certain products has been obtained, and data bearing on the subject have been collected and prepared for publication. Constructive work has also been done in instructing packers in the more sanitary methods of packing their product. One result of the work has been the development among some of the packers of a sense of the importance of sanitary methods in factory practice and the discarding in whole or in part by many factories of practices which resulted in the production of more or less decomposed, and hence objectionable, products. As a final result the class of goods on the market has been much improved. Publications issued: Bureau of Chemistry Circular 68, "Tomato Catsup under the Microscope," and an article entitled "Manufacture of Tomato Sauce."

(2) During 1918: The microscopic studies were continued and preliminary investigations made on the conditions influencing the color, taste, and texture of the final products. Consideration was also given to problems concerning the cost of production. This work has already been conducted sufficiently far to show great variation and lack of uniformity in different plants, which influence the ultimate cost and involve important questions of waste or economy all along the line from producer to consumer. The tests already made have demonstrated possibilities of great improvement as regards efficiency in these lines of manufacture. During the past year the following publications were issued: Department Bulletins—569, "The Sanitary Control of Tomato Canning Factories," and 581, "Microscopical Studies on Tomato Products."

*Assignment.*—B. J. Howard, Chas. H. Stephenson.

*Proposed expenditures, 1918-19.*—\$1,365.

**Total, Microchemical Investigations, \$7,405, including \$970 statutory.**



## WATER INVESTIGATIONS.

**Study of the Methods of Water Analysis:**

*Object.*—To devise new methods of water analysis, improve old methods and unify them, develop methods for accurately measuring radioactivity, study the radioactivity of waters, and determine the content of the rarer constituents of water.

*Procedure.*—Experimental laboratory work is carried on and the literature and results obtained by coworkers in the same field studied.

*Cooperation.*—Association of Official Agricultural Chemists, American Public Health Association, American Chemical Society, and others.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Results.*—(1) Prior to 1918: Results of the work of developing and testing methods of analysis prior to 1918 have been published in Bureau of Chemistry Bulletins 91, 139, and 153, and in numerous annual reports of the referees on water appearing in the proceedings of the Association of Official Agricultural Chemists.

(2) During 1918: The investigation of methods for the accurate determination of iodine and bromine has progressed materially, the experimental work having been completed. The data are now being collated, studied, and prepared for publication.

Methods for the determination of barium, calcium, magnesium, and manganese were studied in cooperation with members of the Association of Official Agricultural Chemists, and the results were reported by the referee at the 1917 meeting of the association. The report of this work has been submitted by the referee, a member of this bureau, for publication in the Journal of the Association of Official Agricultural Chemists.

Preliminary studies were made on methods for the determination of ammonia in waters containing free hydrogen sulphid, which work it is proposed to continue.

*Assignment.*—W. W. Skinner, J. W. Sale.

*Proposed expenditures, 1918-19.*—\$800.

**Sanitary Bottling of Waters:**

*Object.*—To determine the best and most cleanly methods possible in the handling and bottling of waters.

*Procedure.*—The efficiency of bottle-washing machinery, the sterilizing and bactericidal efficiency of washing powders and compounds, and the efficiency of various types of sterilizing machinery are studied. Inspections of bottling plants are made.

*Cooperation.*—Commercial plants.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: The efficiency of certain methods of cleaning bottles has been determined by both chemical and bacteriological studies, the detergent and bactericidal efficiency of certain proprietary and ordinary washing compounds studied, and the efficiency of some new solutions tested.

(2) During 1918: The work on this project was confined to the collation and study of data which had been collected previously and its preparation for publication in the form of a bulletin.

*Probable date of completion.*—1919.

*Assignment.*—W. W. Skinner, J. W. Sale.

*Proposed expenditures, 1918-19.*—\$500.

**Impurities in Brines and Food Salt:**

*Object.*—To investigate the impurities in food salt and their relation to health, to determine the barium chlorid and other impurities in the brines from which food salt is produced, and to develop practical methods for the removal of such impurities in the manufacture of salt.

*Procedure.*—Brine and salt are analyzed and, by experiments in the laboratory and in the salt works, the best methods for removing the impurities determined.

*Cooperation.*—Commercial plants.

*Location.*—Washington, D. C., Pomeroy, Ohio, and other places.



*Date begun.*—1913.

*Results.*—The study of impurities found in salt used for table and dairy purposes has been continued. A series of samples representing these products has been collected and analyzed. The data have been published under the title "The Removal of Barium from Brine Used in the Manufacture of Salt" in the Journal of Industrial and Engineering Chemistry, vol. 9, No. 1.

*Probable date of completion.*—1920.

*Assignment.*—W. W. Skinner.

*Proposed expenditures, 1918-19.*—\$500.

### Examination of Miscellaneous Waters and Related Products:

*Object.*—To aid other bureaus and offices in solving problems in which the character of water, water supplies, salts, and sewage are factors by the determination of their chemical composition and sanitary condition.

*Procedure.*—General analytical and research work is conducted.

*Cooperation.*—Forest Service, Bureau of Biological Survey, Bureau of Public Roads, Bureau of Fisheries, and other department bureaus.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Results.*—(1) Prior to 1918: Many analyses of drainage and spring waters, salt, surface efflorescence, soils, and related products have been made for the branches of the Government mentioned under "Cooperation." The distilled water in the bureau is tested daily. Methods for testing platinum ware have been developed and are in use.

(2) During 1918: The study of the occurrence of manganese in a water supply has been continued. The results have been published as a scientific paper in the Engineering News Record. The results of an investigation of the effects upon the dissolved oxygen and the precipitation by salt water in certain tidal areas have been collated, studied, and published as a scientific paper in the Journal of the Franklin Institute.

*Assignment.*—W. W. Skinner, J. W. Sale, C. H. Badger.

*Proposed expenditures, 1918-19.*—\$2,100.

**Total, Water Investigations, \$3,900, including \$550 statutory.**

### PHARMACOGNOSY INVESTIGATIONS.

#### Pharmacognosy Investigations:

*Object.*—To determine the chemical, physiological, and morphological characteristics of plants and drugs and to devise new and improved methods of analysis.

*Procedure.*—The usual methods applied in pharmacognostic investigations are followed.

*Cooperation.*—Bureaus of Plant Industry and Entomology.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—The work on monographs of mustard and mustard substitutes has been continued. A paper on Chinese Colza (*Brassica campestris* v. *sativa annua chinensis* L. & K.) has been submitted for publication. This discusses the chemical and anatomical characters of the seed, as well as the morphological characters of the plant in the different stages of its growth. These data have been used to prove the close relationship to the Colza group and the distinct difference from the mustards. Considerable work along similar lines has been done, especially on Japanese mustard (*Brassica cernua*, Thunbg.) and Chinese mustard (*Br. juncea*, H. et Th.). Of these the first especially has proved to be a very valuable substitute for certain European species now lacking.

The study of oxalic acid in foods and spices has been extended to spinach, rhubarb, sweet potatoes, and dasheens, and a paper on the whole subject is in preparation for publication.

The work on cyanogenesis has been continued. This consists essentially of a study of the edible and the poisonous beans of the lima type (*Phaseolus lunatus*) and of the glucoside occurring in these beans. A monograph has been prepared for publication discussing the method developed for the determination of the available hydrocyanic acid and the amounts found in samples of beans obtained from this and other



countries. The isolation and acid and enzyme hydrolysis of the glucoside are described, also means to distinguish the poisonous from the harmless beans, and the beans of the lima type from other types; and finally the possible utilization of the poisonous forms is indicated. Beans obtained from sources other than *Phaseolus lunatus*—namely, horse beans (*Vicia faba*), Tepary beans (*Phaseolus acutifolia* var. *latifolia*), jack beans (*Canavalia ensiformis*), velvet beans (*Stizolobium deeringianum*), and Mexican and oriental varieties of common beans (*Phaseolus vulgaris*)—have also been tested for hydrocyanic acid; however, with negative results.

The work on saponin-yielding plants, especially desert plants, has been continued. Manuscripts on *Agave lecheguilla* and *Yucca glauca* (*Yucca angustifolia*) have been prepared for publication. The saponins occur in the cell sap and may be found in the air-dried material as amorphous, more or less yellow, transparent masses, occurring mainly in the veins distributed through the different parts of the plants; especially, however, in root stocks, roots, and axes. The fact that the saponins occur in the cell sap or veins suggests that they, containing one or more molecules of sugar, are not only used as food material but possibly, being generally hygroscopic, also serve to retain moisture within the tissue during the long period of dryness (in the desert).

Notes discussing valuable or objectionable substitutes, the findings concerning the effect of mold and worms on the alkaloid content of areca nuts, the effect of storage on that of jaborandi leaves, the value of volume-weight determinations of drugs as an indication of quality, etc., are under consideration for publication.

A paper on "The Detection of Molds in Foods, Drugs, and Spices" has been published in the Journal of the American Pharmacological Association, 1917, vol. 6, recommending a specific stain for this purpose, which should also prove valuable in the study of fungous diseases.

*Assignment*.—A. Viehoveer, C. O. Johns.

*Proposed expenditures, 1918-19*.—\$5,660, including \$775 statutory.

#### PHYTOCHEMICAL INVESTIGATIONS.

##### Phytochemical Investigations:

*Object*.—To make systematic and complete investigations of various plants and plant drugs in order to determine the nature of their principal organic constituents.

*Procedure*.—Special consideration will be given to such organic constituents of plants as possess physiological activity, inasmuch as these may prove to be of medicinal value. It is also anticipated that the results of many of these investigations may serve to facilitate the detection of various drugs in such medicinal preparations or other products as are subject to surveillance under the food and drugs act. The methods pursued are extremely varied but in general are such as are usually employed in organic chemical research.

*Location*.—Washington, D. C.

*Date begun*.—1916.

*Results*.—Several extended investigations have been undertaken and some preliminary work accomplished. The subjects enumerated and described include the fruit *Ginkgo biloba*, L., the wood of *Pterocarpus indicus*, Willd., the barks of *Viburnum prunifolium* and *V. opulus*, and the bark of *Acer spicatum* or mountain maple.

From genuine chaulmoogra seeds, imported from India, a quantity of pure chaulmoogra oil has been obtained. This oil is largely employed in the treatment of leprosy, being regarded by some as a specific for that disease. It has in past years been very completely investigated with respect to its constituents, and therefore requires no further chemical examination, but it is now proposed to utilize the material from which the fatty oil has been expressed in order to attempt to isolate the glucoside contained in the seed, which yields hydrocyanic (prussic) acid on hydrolysis.

All the above-mentioned researches have been interrupted in order to undertake an investigation suggested by the National Research Council on sources of caffeine other than those usually available. This problem has necessitated a very large amount of experimental work, which will



continue to require the almost exclusive attention of this laboratory for a considerable period of time. The further investigations of the other subjects referred to will, however, be continued as soon as opportunity permits.

*Assignment.*—F. B. Power, V. K. Chesnut.

*Proposed expenditures, 1918-19.*—\$6,610, including \$210 statutory.

#### CATTLE-FOOD AND GRAIN INVESTIGATIONS.

**(Rice and Rice Products:** Project completed. A large number of rice mills were visited during 1916 and authentic samples taken and examined. The results of this investigation have been published in Department Bulletin 570, "The By-Products of Rice Milling." As a result of this investigation, a Service and Regulatory Announcement on "The Addition of Rice Hulls to Rice By-Products" was issued in 1917, and a definite policy relative to handling rice mill by-products under the food and drugs act was decided upon.)

#### Rice Bran and Rice-Bran Oil:

*Object.*—To study the possibility of extracting oil from rice bran commercially, thereby improving the keeping qualities and feeding value of the bran; also to suggest a procedure to rice millers by which they can ship rice bran, containing no excess hulls, without danger of spoiling.

*Procedure.*—Samples of bran from three principal varieties of rice are treated by the Anderson expeller process to determine yields and, in a general way, the properties of the resulting oil and cake, especially the keeping qualities of the cake. This is primarily a feed proposition. However, the oil will be submitted to manufacturers and to the oil, fat, and wax laboratory of this bureau to determine its value.

*Location.*—Washington, D. C.

*Date begun.*—1916.

*Results.*—Samples of bran have been obtained and the oil expressed, and the oil and cake are now being analyzed and studied. No work was performed on this project during the fiscal year 1918, but it is hoped that work can be continued during the current year and oil expressed under commercial conditions.

*Probable date of completion.*—1918.

*Assignment.*—J. B. Reed, G. L. Bidwell.

*Proposed expenditures, 1918-19.*—\$200.

#### Standards for Cattle Foods:

*Object.*—To propose standards for malt sprouts, feed barley, mill oats, cottonseed meal, and other cattle foods.

*Procedure.*—Authentic samples of cattle foods are collected at the source and examined, and methods of manufacture are studied. On the basis of the results obtained, standards are suggested from time to time.

*Location.*—Washington, D. C.

*Date begun.*—1906.

*Results.*—(1) Prior to 1918: A large amount of work has been performed on the investigation of standards. Mills have been visited and samples examined. Manufacturers have been shown that added screenings have no place in bran and other flour-mill by-product feeds, with the result that they have entirely changed their methods of manufacture. Methods have been developed whereby added screenings can be detected. Tentative standards for malt sprouts have been suggested, as well as standards for poultry foods containing silicious grit. Analytical work on standards for cottonseed products was practically completed, and the results of such analytical work are being studied. The practice of treating smutty barley with lime has been studied and a Service and Regulatory Announcement issued. A study was made of oats bleached with sulphur dioxide and a Service and Regulatory Announcement issued. A study was made of the correct branding of mill oats, feed barley, and similar by-products and a report prepared for use in the enforcement of the food and drugs act.

In 1917, a study of flaxseed by-products was inaugurated with the idea of proposing tentative standards and developing methods for detecting adulteration.



(2) During 1918: Tentative standards for weed seeds and other foreign materials in linseed meal, oil meal, old process oil meal, new process oil meal, and ground flax seed were determined. Tentative standards and definitions for hominy feed and other by-products of cornmeal were determined upon and proposed. Work was inaugurated on definitions and standards for peanut by-products. A Service and Regulatory Announcement was prepared on cottonseed meal and hulls containing salt and on the veneering of baled hay. Service and Regulatory Announcements were prepared on proper definitions of alfalfa meal and ground cottonseed hulls.

*Assignment.*—G. L. Bidwell, J. K. Haywood, G. P. Walton.

*Proposed expenditures, 1918-19.*—\$2,250.

**(Effects of Storage and Transportation on Composition of Corn:** This project was undertaken to aid the Bureau of Plant Industry and later the Bureau of Markets in establishing corn grades. The work has now been completed, and corn grades have been promulgated by the Secretary of Agriculture.)

**Total, Cattle-Food and Grain Investigations, \$2,450, including \$200 statutory.**

#### ORGANIC CHEMICAL INVESTIGATIONS.

##### Properties of Amino Acids:

*Object.*—To isolate, identify and determine amino acids, as a basis for the study of the chemical aspects of foods in general and spoilage in particular.

*Procedure.*—Amino acids are prepared in pure condition from native proteins and the various means of obtaining better separations and purifications studied. Such pure acids are used in later work in critical studies looking to the acquiring of information relative to the processes going on in food spoilage.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—No work was done in this project during the past year.

*Probable date of completion.*—1922.

*Assignment.*—I. K. Phelps.

*Proposed expenditures, 1918-19.*—\$1,820.

##### Nonsugars in Natural Sirups and Crude Sugars:

*Object.*—To isolate and identify nonsugars.

*Procedure.*—The constituents of invert sugar are separated and identified, after which the method developed is applied to natural products.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—A study has been made of the possible isolation of dextrose and levulose as sugars and as oxidized products. The results are now in process of being assembled. The work on this project was temporarily discontinued during the fiscal year 1917-18.

*Probable date of completion.*—1922.

*Assignment.*—I. K. Phelps.

*Proposed expenditures, 1918-19.*—\$1,490.

##### Organic Acids of Nature:

*Object.*—To isolate, identify, and determine quantitatively the organic acids of nature.

*Procedure.*—Usual analytical methods are employed to determine the acids in fruits, fruit products, etc.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—Two papers have been published, one describing a method for the identification and estimation of lactic acid and another on a similar method for the isolation and estimation of butyric acid. A study of the application of the method for the determination of lactic acid in fermented fruit products is in progress. This method and also the method for the determination of butyric acid have been studied in their application to fermented tomato products. The determination of tartaric acid in the presence of malic and citric acids has also been studied.

*Probable date of completion.*—1922.



*Assignment.*—I. K. Phelps, H. E. Palmer, H. A. Lepper.  
*Proposed expenditures, 1918-19.*—\$1,830.

**(Separation and Identification of Alcohols in Food Products:** No investigations have been instituted under this project. The particular need for the work seems to have largely disappeared with the general curtailment in the manufacture of distilled liquor throughout the country. The project is therefore abandoned.)

**Study of the Determination of Nitrogen by the Kjeldahl Method:**

*Object.*—To modify the Kjeldahl method for the determination of nitrogen, making it applicable to all substances containing nitrogen, including those on which the present methods will not give accurate results.

*Procedure.*—Experiments with different classes of organic compounds will be conducted until modifications of the Kjeldahl method are found which will be applicable to them.

*Cooperation.*—Association of Official Agricultural Chemists.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—The analysis by the Kjeldahl method of a large number of compounds and substances which had previously resisted this method has been made possible. The substitution of sodium sulphate for the more expensive chemical, potassium sulphate, has been thoroughly investigated and found applicable in most cases. Three preliminary reports were made to the Association of Official Agricultural Chemists in November, 1915, November, 1916, and November, 1917, and three reports to the annual meetings of the American Chemical Society in April, 1916, September, 1916, and April, 1917. These reports are in process of preparation for publication.

*Probable date of completion.*—1920.

*Assignment.*—I. K. Phelps.

*Proposed expenditures, 1918-19.*—\$1,050.

**Total, Organic Chemical Investigations, \$6,190.**

**PHARMACOLOGICAL INVESTIGATIONS.**

**(Investigation of Caffeine and Allied Compounds:** Project completed. Data have been obtained on the effects of caffeine on peristalsis and increase of blood sugar. The pharmacological effect of an isomer of caffeine has been studied and reported in the *Journal of Pharmacology and Experimental Therapeutics*, 1918, vol. 11, No. 81.)

**(Toxicity and Pharmacology of Oil of Chenopodium and Other Essential Oils:** Project completed. It has been shown that the oil of chenopodium is toxic and cumulative, that the poisonous effect increases in starvation, that it depresses circulation and respiration, and that it decreases the irritability of the smooth muscles of the intestines. It has been found that toxicity may be decreased by feeding vegetable oils. An examination of several samples showed variation in activity. It was also found that cardiac depression was produced, as shown in experiments on isolated heart, and that adrenalin and digitalis antagonize depression. Caffeine has no effect or may increase depression caused by oil of chenopodium. Studies made with one member of the group, oil of chenopodium, show that it is rapidly absorbed from the small intestine but very slowly from the stomach. Publications: "Pharmacology of Oil of Chenopodium, with Suggestions for the Prevention and Treatment of Poisoning," *Journal of the American Medical Association*, vol. 69, 1917, p. 2016; and "The Production of Renal Changes by Oil of Chenopodium and Fatty Oils and the Protective Action of Diet on the Kidneys," *Journal of Pharmacology and Experimental Therapeutics*, vol. 9, 1917, p. 529.)

**Pharmacology of Zinc, Tin, and Other Heavy Metals:**

*Object.*—To determine the effect on health of heavy metals when contained in food products.

*Procedure.*—The physiological action of tin and zinc on animals is determined and compared with the effects of other heavy metals.

*Location.*—Washington, D. C.

*Date begun.*—1912.



**Results.**—(1) Prior to 1918: Diabetes and nephritis have been shown to be produced by zinc salts. The elimination of zinc takes place chiefly in the intestines and only slightly in the urine and bile. It is also stored in the bones, muscles, the skin, and the liver. Tin like zinc, decreases the irritability of the smooth muscles but is much weaker. Under certain conditions it may produce nephritis. The metal is stored in the liver, skin, bones, and muscles. The toxicity of zinc compared with nickel shows that the latter is less toxic to the smooth muscles. The influence of lead on the smooth muscles also has been compared with zinc and tin. Data have been obtained on the permeability of the kidneys to dyes in zinc poisoning, also results on acute and chronic tin intoxication.

(2) During 1918: A paper is in process of publication relative to the production of glycosuria from the administration of zinc. Studies on the effect of diet on zinc nephritis in rabbits were continued. Preliminary experiments on the isolated frog heart with the salts of 10 different heavy metals were continued. Experiments on the toxicity of lead for rats and the relation of diet thereto were also made.

**Probable date of completion.**—1918.

**Assignment.**—E. W. Schwartz.

**Proposed expenditures, 1918-19.**—\$2,010.

**(Pharmacological Action of Tartrates and Citrates:** Project completed. It has been determined that nephritis and acute and subacute intoxication in different animals are produced by tartrates, that diet is an important factor in determining toxicity, that tartrate is a heart depressant, that the depressing effect of citrate on the heart is greater than that of tartrate, that citrate disappears rapidly from the circulation, and that citrate is oxidized in the body. Herbivorous animals oxidize it better than carnivorous. When given by mouth it is oxidized almost entirely in the intestines. If administered subcutaneously or intravenously it is oxidized by the tissues. Malate, like tartrate, is also oxidized better in herbivorous than in carnivorous animals. It has been found that the action of citrates is cumulative and that tolerance to tartrates is acquired. Extensive studies have been made to show the effect of diet on toxicity. It has been found that large quantities of tartrate are eliminated after subcutaneous injection and when administered by mouth to different animals. The action of citrates, tartrates, malates, and succinates upon the isolated intestine was reported in the *Journal of Pharmacology and Experimental Therapeutics*, vol. 9, 1917, pp. 497-511.)

**(Pharmacological Action of Turpentine:** Project discontinued. It has not been possible to devote the time necessary to properly carry forward this work.)

#### **Physiological Tests of Ergot, Cannabis Indica, Digitalis, etc.:**

**Object.**—To conduct physiological tests of ergot, *Cannabis indica*, and digitalis, to ascertain the quality of the drugs.

**Procedure.**—The physiological effect of these drugs is determined by experiments on animals.

**Cooperation.**—Bureau of Plant Industry.

**Location.**—Washington, D. C.

**Date begun.**—1913.

**Results.**—(1) Prior to 1918: Physiological studies have been made on ergot obtained from various sources and on *Cannabis indica*. Tests were made on samples of food products.

(2) During 1918: Physiological standardization tests of import and certain other samples of *Cannabis indica*, digitalis, and Squills were performed. Tests were made on various food products, toxic substances, cathartic resins, dyes, etc.

**Assignment.**—E. W. Schwartz.

**Proposed expenditures, 1918-19.**—\$670.

**(Pharmacology and Toxicology of Lac Dyes:** Project completed. Lac dye has been found to be toxic for different animals. Data on the elimination of lac dye and carminic acid have been obtained.)

#### **Pharmacology and Toxicology of Food Colors:**

**Object.**—To study the pharmacology and toxicity of dyes in order to determine their effect on health when used to color foods.



*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—A large number of dyes have been studied and data secured on their physiological action, including their elimination. A number of water-soluble dyes and zinc were found to be synergistic. Erythrosin was found to be an exception, as it was antagonistic to zinc. Studies have also been made on the influence of some dyes on individual organs and their elimination in health and disease. Studies in the duration of the elimination were continued. Experiments with water-soluble dyes were performed on the isolated frog heart. Results were published in the *Journal of Biological Chemistry*, 1916, vol. 27, page 403.

*Probable date of completion.*—1921.

*Assignment.*—E. W. Schwartz.

*Proposed expenditures, 1918-19.*—\$2,685.

**Total, Pharmacological Investigations, \$5,365, including \$720 statutory.**

#### CARBOHYDRATE INVESTIGATIONS.

**(Investigations of Maple Products:** Project completed. Information and labels for a general index of manufacturing conditions and trade practices were collected. This involved the study of the manufacture of sirup, the effect of improved apparatus, etc., and of trade and factory methods of refining and packing, carried out by trips to maple camps and packing houses, where samples were secured and sent to Washington for analysis. Methods for detecting adulteration in maple sirup were studied.)

#### Chemical Investigations of Pure and Adulterated Honey:

*Object.*—To test methods for determining the adulteration of honey by addition of cane sugar, commercial invert sugar, or glucose; to investigate granulation and other changes in honey upon storage; to study the analysis of honey-dew and dextrorotatory honeys and methods for the detection and estimation of added commercial glucose; and to determine the use and value of this type of honey for food purposes.

*Procedure.*—The study of methods is carried out in the laboratory at Washington on representative samples of honey.

*Cooperation.*—Office of Bee-Culture Investigations, Bureau of Entomology.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—It has been found that the crystallization of honey can be retarded or prevented by slight increases in the percentage of levulose in the honey. A preliminary study of the honey-dew type of honey has been made.

Owing to the pressure of other work and the shortage of the force in the laboratory, no work on this project was done during the past year.

*Probable date of completion.*—1921.

*Assignment.*—C. S. Hudson.

*Proposed expenditures, 1918-19.*—\$570.

#### Candy Investigations:

*Object.*—To study the physical and chemical changes which occur during the manufacture and keeping of candy.

*Procedure.*—In order to learn the methods of making the simple and the more complex types of confectionery, visits are made to confectionery factories and experiments conducted in the laboratory to establish the limits and proportions of ingredients, the temperatures of cooking, and related details.

*Cooperation.*—Several large candy manufacturers and members of the National Confectioners' Association.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—Because of the pressure of other work and the shortage of the laboratory force no work was done on this project during the past year.

*Probable date of completion.*—1921.

*Assignment.*—C. S. Hudson, J. Hamilton.

*Proposed expenditures, 1918-19.*—\$570.



(Investigations in the Manufacture and Analysis of Fruit Sirups, Jams, Preserves, Jellies, and Marmalades: Project discontinued, owing to the resignation of the leader and inability to arrange for the continuation of the work at the present time. Improved methods for making clear jellies, particularly apple jelly, were developed. This work was done in factories and in the laboratory in Washington. Assistance was given the various canning clubs of the Southern States. Successful methods were also worked out for the preservation of grapefruit juice on a commercial scale.)

#### Preparation of Pure Carbohydrates:

*Object.*—To find the best methods for preparing the various sugars and other carbohydrates in pure condition.

*Procedure.*—Experimental investigations carried out in the chemical laboratory.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: A method has been devised for the preparation of the sugar arabinose from beet pulp. Xylose has been prepared from cottonseed hulls and from corn husks. Improved methods have been devised for preparing the sugar raffinose, trehalose, the alpha and beta forms of glucose, mannose, melibiose, and galactose in pure condition; also for the preparation of the sugars xylose, cellose, and  $\beta$ -galactose in pure condition.

(2) During 1918: A method was devised for the preparation of xylose from corncobs. Improvements have been made in the method of preparing raffinose and mannose.

*Probable date of completion.*—1920.

*Assignment.*—C. S. Hudson, J. Hamilton.

*Proposed expenditures, 1918-19.*—\$2,965.

#### Physical and Chemical Constants for Pure Carbohydrates:

*Object.*—To measure the optical rotation and other properties by which the carbohydrates are distinguished from one another.

*Procedure.*—Experimental investigations are carried out in the chemical laboratory.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—(1) Prior to 1918: The rotatory powers of the alpha and beta forms of nearly all the sugars have been measured, and a number of publications have appeared as listed in previous reports of the work.

(2) During 1918: Many derivatives of the sugars have been prepared. The following articles have been published: "The Rotatory Powers of the Amides of Active  $\alpha$ -Hydroxy Acids," "Methyl Tetronic Acid and Its Amide," "The Isomeric Tetra-acetates of l-Arabinose and Beta-triacetyl-methyl-l-arabinoside," and "Tri-acetyl-d-xylose and Alpha Tri-acetyl-methyl-d-xyloside." An article entitled "Some Derivatives from the Rhamnose Series of the Sugars" is in course of preparation.

*Probable date of completion.*—1920.

*Assignment.*—C. S. Hudson, J. K. Dale, K. P. Monroe.

*Proposed expenditures, 1918-19.*—\$3,555.

#### Methods of Analysis for Carbohydrates:

*Object.*—To test and improve general methods of analysis for carbohydrates and to utilize the selective action of enzymes in new analytical methods.

*Procedure.*—Experimental investigations are carried out in the chemical laboratory.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—The preparation of invertase for the estimation of cane sugar by the enzymotic method has been improved. Owing to the shortage of the force in the laboratory no other work was done on this project during the past year.

*Probable date of completion.*—1920.

*Assignment.*—C. S. Hudson, K. P. Monroe.

*Proposed expenditures, 1918-19.*—\$2,340.



**Detection of the Characteristic Carbohydrates in Drug Plants and Foodstuffs:**

*Object.*—To isolate and determine the characteristic sugars in drug plants and foodstuffs, in order that these substances may be used as characteristic tests for the presence or absence of the respective plant material in drugs and foods which come under examination.

*Procedure.*—Experimental investigations are carried on in the chemical laboratory.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) Prior to 1918: A new sugar, d-mannoketo-heptose, was obtained from the avocado; work conducted on the new sugar sedoheptose from *Sedum spectabile*; the sugar apiose, occurring in parsley seed, studied and prepared; and a study made of the carbohydrate constituents of gentian root.

(2) During 1918: The following publications were issued: "Sedoheptose, a New Sugar from *Sedum Spectabile*" and "The Rotatory Powers of Some New Derivatives of Gentiobiose." The manna from the Douglas spruce was investigated and found to consist largely of the rare sugar melezitose. An article on this work will shortly be published. A good method for preparing rhamnose from black-oak bark has been worked out in detail. A considerable number of vegetable materials have been examined to determine their sugar content.

*Probable date of completion.*—1920.

*Assignment.*—C. S. Hudson.

*Proposed expenditures, 1918-19.*—\$2,865.

**(Method of Manufacture and Composition of Commercial Invert Sugar:**

Project completed; report of results in preparation.)

**Investigation of the Manufacture and Composition of Maple Sirup:**

*Object.*—To investigate and improve methods of manufacturing maple sirup and to study the effect of partial fermentation upon the composition of the sirup; to prevent crystallization of sirup by partially inverting the sucrose; and to study the utilization of the waste products occurring in connection with the manufacture of maple sirup.

*Procedure.*—Visits will be made to sugar camps and packing houses to collect samples and carry out experiments on the manufacture of the sirup. The sirups made and collected will be analyzed in the laboratory in Washington.

*Cooperation.*—Maple-sirup makers and packing houses.

*Location.*—Washington, D. C.

*Date begun.*—1918.

*Assignment.*—C. S. Hudson, J. K. Dale.

*Proposed expenditures, 1918-19.*—\$1,715.

**Total, Carbohydrate Investigations, \$14,580, including \$1,285 statutory.**

(See also Supplement—Emergency Activities, p. 577.)

**DAIRY INVESTIGATIONS.**

**(Determination of Alkali in Butter:** Superseded by project "Study of Methods for Detecting the Presence of Decomposed Products in the Manufacture of Butter.")

**Study of Methods for Detecting the Presence of Decomposed Products in the Manufacture of Butter:**

*Object.*—To devise methods for the detection of alkali used in the manufacture of butter, and to develop, if possible, chemical methods and tests which will detect different stages of rancidity and other forms of decomposition that take place in aged or spoiled butter, with a view to ascertain the nature of the nonfatty constituents which render the butter unfit for food.

*Procedure.*—The alkalinity and phosphoric acid of the inorganic salts of butter made from cream neutralized with soda ash, milk of magnesia, or other reagents used by creameries are determined. A complete analysis of samples of fresh butter of known history is made. An examination of the fat of the fresh butter is made by the usual methods, and samples of butter at different stages of rancidity and other forms of decomposition are similarly examined.



*Cooperation.*—Bureau of Animal Industry, State inspectors, and creameries.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: The alkalinity-phosphoric acid ratio of the ash of butter was investigated and found to be unreliable for detecting the presence of neutralizers.

(2) During 1918: A method has been devised for obtaining the alkalinity and phosphoric acid of the ash of the inorganic salts of milk, cream, buttermilk, and butter, and many samples have been examined.

*Probable date of completion.*—1919.

*Assignment.*—L. W. Ferris.

*Proposed expenditures, 1918-19.*—\$1,460.

### Study of Artificial Cream:

*Object.*—To develop, if possible, methods for distinguishing (1) homogenized cream, (2) cream made from sweet unsalted butter, milk powder, and butter, and (3) cream made from old unsalted butter, treated in some way with either fresh skimmed milk or with dried milk and water.

*Procedure.*—Samples of these artificial creams, prepared in different ways, are procured and an investigation made to determine whether the sample can be identified by one or more of the following methods or any other method that may be developed: Microscopic test; deposit by centrifugalizing; nitrate tests as evidence of added water; CaO in ash; and relation of alkalinity of ash to  $P_2O_5$ .

*Cooperation.*—Creameries.

*Location.*—Washington, D. C.

*Date begun.*—1916.

*Results.*—(1) Prior to 1918: Fifteen samples of sweet cream—11 homogenized and 4 unhomogenized—and 8 samples of butter have been examined. Sixty cubic centimeter portions of the cream samples were centrifugalized, a complete analysis made, and the analytical data compared. No appreciable difference was found in the distribution of the protein between the artificial creams and the fresh homogenized creams, but considerable difference was found in the distribution of the fat between the homogenized and unhomogenized samples when compared in this manner. The degree of acidity of the fat of fresh cream, artificial cream, and fresh and aged butter is now being investigated to determine whether or not the use of storage butter in the manufacture of artificial cream can be detected in this way. No conclusions can as yet be drawn on this point. The alkalinity and phosphoric-acid content of the ash of six samples of artificial cream were also determined.

(2) During 1918: The degree of acidity of fat was determined in 6 samples of natural cream, 1 sample of artificial cream, 1 sample of sweet cream butter, and 4 samples of country butter. Experiments in washing the fat from the protein precipitated with  $CuSO_4$  were made on 6 samples of cream. Experiments in centrifugalizing were made on 26 samples of cream, of which 13 were homogenized, 8 not homogenized, and 5 artificial. Analyses were made of the whole cream and the lower half of the centrifugalized portions. Sour portions of some of these creams were also treated in like manner. CaO in the ash of some of the artificial creams was determined, while in one the soluble ash, total  $P_2O_5$ , and  $P_2O_5$  in soluble ash were determined. The CaO in the ash of all the artificial creams examined except one indicated liming. The casein, albumin, and total nitrogen were determined on 6 samples of cream, 4 natural, and 2 artificial. It is proposed that a variety of samples of artificial creams be obtained and the casein, albumin, and total nitrogen, the CaO,  $P_2O_5$ , and alkalinity of the ash, together with the freezing point, be made the subject of further research.

*Probable date of completion.*—1919.

*Assignment.*—O. L. Evenson.

*Proposed expenditures, 1918-19.*—\$1,245.

**Total, Dairy Investigations, \$2,705.**



## BEVERAGE INVESTIGATIONS.

**Investigation of the Composition of Foreign Ports and Sherries and Other Wines:**

*Object.*—To determine the composition of typical samples of wine, including so-called vegetable wines and so-called fruit wines other than grape, which are of known origin and which have been produced under known conditions.

*Procedure.*—In the case of foreign wines, samples are procured either through the State Department or through the customs officials at the ports of entry. In the case of domestic wines these are prepared by or under the supervision of a representative of the bureau and then analyzed.

*Cooperation.*—Viticulturists of the Bureau of Plant Industry.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: Twenty-one samples of port wines, collected through the State Department and through the New York station of the bureau, have been analyzed, as have also four samples of sherry secured through a New York importer. Three varieties of *Rotundifolia* grapes, purchased in North Carolina, were made into wine at Charlottesville, Va., the wines being analyzed before fermentation was completed. After proper aging and bottling, these wines will be analyzed again. Samples of port and Madeira wines exhibited at the recent Panama-Pacific Exposition have been procured for analysis.

(2) During 1918: No work was done on this project during the past fiscal year.

*Assignment.*—H. S. Paine, M. J. Ingle.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

**(Study of the Composition of Nonalcoholic Beverages:** Discontinued as a separate project; included under "Study of the Composition of Flavors, Extracts, and Sirups Used in the Preparation of Soft Drinks.")

**(Investigation of the Composition of Brandies:** Project discontinued. With the gradual disappearance of brandies from the markets of the country, the particular need for work of this character no longer exists.)

**(Investigation of the Composition of Cordials:** Work discontinued, for the reason stated under preceding project.)

**(Investigation of the Composition of Malt Beverages:** Project completed. The results of the examination of malt liquors made from materials including six-row barley malt (except Pacific-coast six-row barley malt) have been compiled and submitted for publication. Investigation has shown that the amount of two-row barley malt used in brewing in this country is practically negligible.)

**(Study of Methods of Analysis of Distilled Liquors:** Project discontinued. With the general disappearance of distilled liquors from the markets of this country, the special need for this work is no longer apparent.)

**Investigation of Soft Drinks:**

*Object.*—To determine the factors that govern the successful production of soft drinks, with a view to the prevention of loss through deterioration, and to demonstrate by laboratory investigation, supplemented by test runs in the works, the relation of the water supply, the character of materials employed, and clean conditions in the factory to the appearance and quality of the finished product.

*Procedure.*—Studies are made to determine (a) the relation of the use of impure water or water of high organic content to the production of "flat sours;" (b) the sanitation of the bottling works in relation to the production of "flat sours;" (c) effect of carbonic-acid gas in preventing "flat sours;" (d) character and composition of sirups used in the preparation of soft drinks; and (e) relation of the mineral character of the water supply to the production of cloudiness. The conditions as they exist in typical factories, both good and bad, are inspected



to determine where and to what extent improvement in the methods is needed.

*Cooperation.*—Manufacturers of soft drinks and bottling machinery.

*Location.*—Washington, D. C., and the field.

*Date begun.*—1917.

*Results.*—During the past year studies were made of methods for the determination of ginger and capsicum in certain soft drinks and of the influence of solvents in the extraction of certain desirable flavors used in the manufacture of soft drinks. A comprehensive plan was perfected for the study of the development of microorganisms in bottled soft drinks. The substitution of sweetening agents other than ordinary sugar was studied; one paper on the subject has been accepted for publication in the National Bottlers' Gazette, and data for two other papers have been prepared for the same purpose. Inspection of numerous bottling establishments was made to determine the sanitary condition under which soft drinks are prepared. Conferences were held with numerous manufacturers of extracts and flavors for the purpose of studying problems in the preparation of such products and the factors which affect the quality of the goods being supplied by the trade.

*Assignment.*—W. W. Skinner, J. W. Sale.

*Proposed expenditures, 1918-19.*—\$2,600.

### **Study of the Composition of Flavors, Extracts, and Sirups Used in the Preparation of Soft Drinks:**

*Object.*—To determine the composition of representative samples whose origin and conditions of production are known.

*Procedure.*—A field survey of trade practices with respect to the manufacture of these extracts, flavors, and sirups is being completed, and typical samples produced under the observation of a representative of the bureau are analyzed. New methods for the analysis of such products will be devised, if necessary.

*Cooperation.*—Various manufacturers of flavors, extracts, and sirups.

*Location.*—Washington, D. C., and the field.

*Date begun.*—1915.

*Results.*—A partial survey of trade practices in the carbonated beverage industry, with special study of ginger ale, has been made. Samples of ginger and capsicum ales were made and analyzed and are being stored to note the stability of the flavor.

A survey of trade practices was completed during the past fiscal year.

*Probable date of completion.*—1919.

*Assignment.*—H. S. Paine, M. J. Ingle.

*Proposed expenditures, 1918-19.*—\$1,825.

**Total, Beverage Investigations, \$4,425, including \$600 statutory.**

### **DRUG INVESTIGATIONS.**

#### **Methods of Drug Analyses:**

*Object.*—To develop and study methods of analysis of drug products.

*Procedure.*—Established methods are investigated and, if found adequate, are used; otherwise new methods are developed.

*Cooperation.*—Bureau of Plant Industry, State and municipal officials, and Association of Official Agricultural Chemists.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—A number of methods of analysis have been worked out and published, including methods for the estimation of acetanilid and phenacetin in admixture, of antipyrin, of caffeine and antipyrin, and of phenacetin and salol in admixture, and for the determination of santonin. Methods for the estimation of theobromin and of monobromated camphor in migraine tablets, and for the separation of aluminum from iron by means of ether, have also been developed.

*Assignment.*—L. F. Kebler, W. O. Emery, E. K. Nelson, S. Palkin, D. F. Brauns.

*Proposed expenditures, 1918-19.*—\$4,800.

#### **Permissible Variations in Drug Products:**

*Object.*—To determine what should constitute permissible variations in the composition of drug products under different conditions.



*Procedure.*—The products are subjected to a physical and chemical examination and the results considered in connection with data obtained from material of known composition and manufactured under known conditions.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—Permissible variations in tablets, tincture of ginger, and spirits of nitrous ether have been determined.

*Assignment.*—L. F. Kebler, Wm. F. Kunke, D. F. Brauns.

*Proposed expenditures, 1918-19.*—\$2,500.

#### **Elimination of Inert and Objectionable Material in Crude Drugs and Spices:**

*Object.*—To study methods of elimination of inert and objectionable material found in crude drugs and spices.

*Procedure.*—The nature and extent of contamination are ascertained by the aid of physical methods and appropriate means of rectification suggested or applied.

*Cooperation.*—Bureau of Plant Industry and State and municipal officials.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Results.*—General information has been obtained regarding the cleaning of different types of crude drugs and spices by washing, flotation, sifting, blowing, scraping, and other methods, based on difference in weight, size, shape, or consistency. Specific information has been collected in the cases of wormy and moldy nutmegs, areca nuts, ginger, orris root, and mustard seed.

*Assignment.*—A. Viehoveer.

*Proposed expenditures, 1918-19.*—\$350.

#### **Improvement of the Methods of Identification of Alkaloids in Drugs:**

*Object.*—To study the properties of alkaloids and their derivatives for the purpose of improving the methods of identification of these substances in drugs.

*Procedure.*—Experimental investigations are carried on in the chemical laboratory.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—Owing to the impossibility of obtaining material necessary for this work, investigations in this field were suspended during the past year.

*Probable date of completion.*—1920.

*Assignment.*—F. B. La Forge.

*Proposed expenditures, 1918-19.*—\$3,100.

#### **Examination of the Quality, Purity, and Character of Chemical Reagents for Analytical Work:**

*Object.*—To secure reliable chemicals for use in the bureau's investigations.

*Procedure.*—Chemicals are examined to determine the nature and character of objectionable impurities, if any.

*Location.*—Washington, D. C.

*Date begun.*—1903.

*Results.*—The chemicals supplied to the Bureau of Chemistry have been regularly examined and such reagents as have been found defective rejected. The quality of chemical reagents submitted under contract or otherwise has been, on the whole, of a lower grade than for a number of years past. It has been at times impossible to secure some chemicals of satisfactory quality for analytical work.

*Assignment.*—L. F. Kebler, H. E. Buc, W. Heath.

*Proposed expenditures, 1918-19.*—\$2,500.

#### **Cooperation with the United States Pharmacopoeia Committee:**

*Object.*—To develop and study methods of analysis, establish limitations of tolerances, and collect data for the establishment of standards.

*Procedure.*—A study will be made of such problems as may arise in conjunction with the revision of the United States Pharmacopoeia, one of the standards in use in connection with the enforcement of the food and drugs act.



*Cooperation.*—United States Pharmacopoeia Committee.

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Results.*—The possibility of modifying the formulæ so as to conserve some of the alcohol, glycerin, and sugar now used has been studied and the situation discussed with the Food Administration.

*Assignment.*—L. F. Kebler, W. H. Heath.

*Proposed expenditures, 1918-19.*—\$545.

**Total, Drug Investigations, \$13,795, including \$1,300 statutory.**

**Total, Enforcement of the Food and Drugs Act, \$789,226, including \$238,945 statutory (research, \$164,290; regulation, \$624,936).**

## INVESTIGATION OF NAVAL STORES AND DEMONSTRATION OF METHODS OF PRODUCTION.

### [Research.]

#### Investigation of the Grading, Weighing, Handling, and Uses of Naval Stores:

*Object.*—To improve the methods of grading, weighing, and handling of naval stores; to secure the adoption of a definite and universal procedure in grading, weighing, and handling of rosin and turpentine, so that the producers may be paid full value for their product and that the buyer may secure delivery of the grade purchased; to secure data to serve as a basis for the authoritative adoption of standard grades of naval stores; and, through chemical investigations, to develop new uses for turpentine and rosin.

*Procedure.*—The distillation, packing, grading, weighing, and handling of naval stores are studied and observed at the stills of the producers, at the primary yards of the country, in the hands of the larger buyers, and finally in the hands of the users. Shipments are followed from producer to user for the purpose of discovering improper practices in dealings, if any, with a view to make necessary changes in methods of production, grading, packing, weighing, and marketing.

*Cooperation.*—The naval-stores industry; National Oil, Paint, and Varnish Association; Savannah Board of Trade; State naval-stores inspectors of Georgia and Florida; Turpentine and Rosin Producers Association of New Orleans; and inspectors of the New York Produce Exchange.

*Location.*—Headquarters, Washington, D. C., and Savannah, Ga.; experiments made at 15 or 20 stills in North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas; experimental gradings and weighings at New York City, Cincinnati, Ohio, Savannah, Ga., Jacksonville, Fla., and at other large cities and in the hands of users.

*Date begun.*—1910.

*Results.*—(1) Prior to 1918: Grading, weighing, and handling of naval stores have been studied in the field at points of production, distribution, and consumption. A simple and accurate method for grading at the still has been devised. Three publications dealing with adulteration, misgrading, methods of examination, standards, grading at the still, and uses of turpentine and rosin have been issued. The losses arising from misgrading and adulteration, borne either by the producers or consumers, have been indicated in these publications. Instructions on grading have been prepared, together with improved equipment therefor. Distillation practices have been studied at many stills, in connection with the grading and weighing work, and many data on cost of various operations have been compiled.

(2) During 1918: Additional information on weighing, grading, and handling naval stores and on losses at the stills was collected. The accuracy of commercial grading of rosin was further investigated, and the extent to which rosin is misgraded and turpentine is adulterated was determined. Results show that both practices are still widely prevalent. A report covering the results of the investigations of the grading, weighing, and handling of naval stores is in course of preparation. New uses for turpentine and rosin are being investigated.

*Assignment.*—F. P. Veitch, V. E. Grotlisch.

*Proposed expenditures, 1918-19.*—\$4,000.



**Preparation of Definite Type Samples for Naval Stores:**

*Object.*—To prepare definite and permanent type samples as a basis for trading, and to insure fair, uniform, and simple grading of naval stores.

*Procedure.*—Work is being done on the measurement of color in rosin and turpentine types and on the expression of these colors in definite terms. Replicas are prepared of the permanent type samples for rosin and turpentine developed by the bureau and adopted by the various trade bodies having supervision over dealings in naval stores.

*Cooperation.*—Naval-stores industry; Savannah Board of Trade; State naval-stores inspectors of Georgia and Florida, and inspectors of the New York Produce Exchange.

*Location.*—Headquarters, Washington, D. C.

*Date begun.*—1911.

*Results.*—(1) Prior to 1918: Durable, accurate, and practical permanent type samples for rosin, made of glass, have been devised and distributed for preliminary practical experience and observation. These types have been adopted as official by the Savannah Board of Trade, the New York Produce Exchange, the New Orleans, Jacksonville, and Mobile Boards of Trade, and other commercial bodies having regulations governing trading in naval stores. Progress has been made in developing types for turpentine, and a simple apparatus for grading turpentine has been distributed for preliminary experience and observation. Specifications for the standard color grades for turpentine have been suggested and adopted by the above-mentioned trade bodies.

(2) During 1918: Additional sets of glass rosin type samples have been distributed among the stations of the Bureau of Chemistry for use by commercial concerns desiring the loan of permanent type samples for grading shipments of rosin. The rosin type samples in general use by the trade are being made to conform to the permanent glass type samples. A simple colorimeter for determining the color grade of turpentine and similar liquids in terms of a practical unit was devised and a paper thereon published.

*Assignment.*—V. E. Grotlisch.

*Proposed expenditures, 1918-19.*—\$1,000.

[Extension.]

**Demonstration of Improved Methods or Processes of Preparing Naval Stores:**

*Object.*—To give instructions and demonstrations in distilling and handling naval stores, in the saving of raw materials now being wasted, and in the making of better products, to the end that the naval-stores industry may be conducted on an economical basis.

*Procedure.*—Demonstration of improved procedures in naval-stores operations are conducted by experienced department agents.

*Cooperation.*—Naval-stores producers throughout the Southern States.

*Location.*—Headquarters, Washington, D. C.; demonstrations made in Georgia, North Carolina, Florida, Alabama, South Carolina, Mississippi, Louisiana, and Texas.

*Date begun.*—1916.

*Results.*—(1) Prior to 1918: This work is a development from the project "Investigation of the Grading, Weighing, Handling, and Uses of Naval Stores." Turpentine stills were visited and the operation, equipment, and processes studied. Producers urged that the department send trained men into the field to demonstrate how to prevent losses and how to produce naval stores more economically by the use of improved and more efficient methods and equipment, that legislation be enacted establishing Federal supervision of the grading, gauging, and weighing of naval stores, that definite, reliable statistics of production be compiled and issued at regular intervals, and that permanent type samples be prepared for all who may desire them. Information as to the needs of the industry has been collected.

(2) During 1918: Two demonstration parties were kept in the field during the producing season of 1917-18, and as many as possible of the turpentine stills throughout the southern naval-stores producing section were visited. Improved and efficient processes and equipment were demonstrated. This work was supplemented by lectures, circular letters, and a series of posters bearing on different phases of naval-stores production



distributed among the operators. A practically complete list of turpentine producers, with addresses, has been compiled. A report of the work carried on for the benefit of the naval-stores industry is in course of preparation.

*Assignment.*—F. P. Veitch, V. E. Grotlisch.

*Proposed expenditures, 1918-19.*—\$5,120.

**Total, Investigation of Naval Stores and Demonstration of Methods of Production,** \$10,120, including \$120 statutory (research \$5,120; extension, \$5,000).

[Research.]

## INSECTICIDE AND FUNGICIDE INVESTIGATIONS.

### Toxic Effect of Sprays on Fruit Trees Through the Medium of the Soil:

*Object.*—To determine whether or not orchards can be injured by poisonous sprays acting through the medium of the soil and, if so, under what conditions this occurs and how to remedy it.

*Procedure.*—Samples from sprayed and unsprayed trees, which have or have not been treated with various poisonous spraying materials, and soils in which the trees are growing are collected by the Bureau of Entomology. These samples, of which a complete history is kept, are examined by the Bureau of Chemistry.

*Cooperation.*—Bureau of Entomology.

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—Chemical work completed; data ready for collation, with the idea of publication as a bulletin. The significance of the results can not be determined until the data have been studied.

*Probable date of completion.*—1919.

*Assignment.*—J. K. Haywood, C. C. McDonnell.

*Proposed expenditures, 1918-19.*—\$200.

### Foliage Injury by Lead Arsenate and Other Insecticides:

*Object.*—To determine what causes foliage injury in triplumbic arsenate; to determine the action of various impurities in lead arsenate on foliage; to discover spray mixtures which, while acting in an efficient manner as insecticides, will produce minimum injury to tender foliage.

*Procedure.*—Samples of known composition are prepared and subjected to test in the orchard, and the results observed.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1898.

*Results.*—It has been confirmed that diplumbic arsenate burns, whereas triplumbic does not burn, and that certain by-products found in the preparation of lead arsenate do not burn. Results of part of the work have been published in Bureau of Chemistry Bulletin 131, "Lead Arsenate." The action of various solvents on diplumbic arsenate has been studied. It was found that certain of these solvents, which are present in ordinary water, act on diplumbic arsenate and set soluble arsenic free, thus resulting in a burning of the foliage. The results of this investigation were published in the American Journal of Science, vol. 42, No. 248, under the title "The Preparation and Properties of Lead Chlor Arsenate." Three other papers on "The Arsenate of Lead" and one entitled "The Action of Water on Di-lead Arsenate" have also been published.

*Assignment.*—J. K. Haywood, C. C. McDonnell.

*Proposed expenditures, 1918-19.*—\$100.

### Analysis of Insecticides and Fungicides:

*Object.*—To aid other bureaus of the department, especially the Bureau of Entomology, in solving problems which require chemical investigations of an insecticidal or fungicidal nature.

*Procedure.*—When other bureaus of the department meet insecticidal and fungicidal problems which require chemical investigation, the facts are submitted to the Bureau of Chemistry and the necessary investigations undertaken to solve such problems.

*Cooperation.*—Bureaus of Entomology and Plant Industry.



*Location.*—Washington, D. C.

*Date begun.*—1900.

*Results.*—Ascertained facts are transmitted to the bureaus interested. Results of certain of these investigations have been published as bulletins of the Bureau of Chemistry. Other results have been published in Bureau of Entomology bulletins. Investigations were undertaken for the Bureau of Entomology on the chemical problems connected with fumigation with hydrocyanic-acid gas; as to the amount of arsenic in bees and parts of bees feeding on blossoms sprayed with arsenicals; in connection with the preparation of new tree-banding materials; and concerning the preparation of insecticides used against certain insects on cotton; and analyses have been made of a considerable number of insecticides. An investigation was made for the Bureau of Plant Industry of the copper content of tomato plants which had been fed with copper through the medium of the roots.

In the past the following publications have been issued under this project: Bureau of Chemistry Bulletins—82, "Paris Green Spraying Experiments," and 131, "Lead Arsenate"; and Bureau of Entomology Bulletin 90, part 3, "The Chemistry of Fumigation with Hydrocyanic-Acid Gas."

During 1916 large quantities of a new tree-banding material were prepared and tested out in the field, the results of the work being published in the Journal of Economic Entomology under the title "A New Tree Banding Material for the Control of the Gipsy Moth." Work on the fumigation of cotton bales with hydrocyanic-acid gas against the pink bollworm has been continued. Studies were made of the cyanide and arsenic content of plants treated with cyanides and arsenical compounds by inoculation and through the roots.

During 1917 and 1918, chemical investigations were made for the Bureau of Plant Industry of the foliage of trees sprayed with lime-sulphur and copper sprays, with and without stickers, to determine the effectiveness of stickers; also to determine the sticking qualities of various copper and sulphur sprays.

During 1918 an investigation was made to determine the amount of hydrocyanic acid remaining in food products fumigated with hydrocyanic-acid gas. The time element was carefully investigated. Investigations were made for the Bureau of Plant Industry of the formaldehyde content of solutions used in treating certain grain smuts. Investigations were made for the Bureau of Entomology of the chemical and physical composition of mineral oils used in citrus spraying work.

*Assignment.*—J. K. Haywood, C. C. McDonnell, F. C. Cook.

*Proposed expenditures, 1918-19.*—\$3,200.

### **Study of the Chemical Composition and Efficiency of Pickering Bordeaux Mixture.**

*Object.*—To determine the composition of Pickering Bordeaux mixture prepared in various ways, and to ascertain whether Pickering formulas can be applied under American field conditions so as to accomplish effective control of fungous diseases and at the same time not burn the foliage of the plants. The ultimate object of the study is to use Pickering Bordeaux mixture instead of the standard Bordeaux mixture, if this appears to be possible, since the Pickering Bordeaux contains much less copper than standard Bordeaux and is, therefore, very much cheaper—a point which is very important under usual conditions and especially so at the present time.

*Procedure.*—Various Pickering Bordeaux formulas will be prepared by the Bureau of Chemistry and tested out in the field on apples, potatoes, grapes, and tomatoes in collaboration with the Bureau of Plant Industry. Chemical examinations will be made of the mixtures, as well as of the foliage, the latter analyses being to determine the amount of Pickering Bordeaux remaining on the leaves and its sticking qualities.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Washington, D. C., and various points in the field where the Bureau of Plant Industry is carrying on spraying experiments.

*Date begun.*—1918, as a separate project; previous work done in connection with other projects.

*Results.*—A large amount of data has been obtained. Interpretation of the results can not be attempted, however, until this information has been collated at the close of the investigation.



*Assignment.*—F. C. Cook, J. K. Haywood, C. C. McDonnell.

*Proposed expenditures, 1918-19.*—\$2,500.

**Investigation of the Chemical Problems Involved in Spraying Plants with Pickering and Other Copper Sprays:**

*Object.*—To determine the effect of Pickering and other copper sprays in increasing the yield of potatoes and other plants and the effect of such copper sprays on the composition of the tubers; to study the absorption and distribution of copper in sprayed plants and the mode of action of copper in producing increased yields and altering the composition of vegetables and fruits; and to compare the action of Pickering with other copper sprays in increasing yield and altering composition and the mode of their action.

*Procedure.*—Various Pickering Bordeaux formulas and other copper sprays will be prepared by the Bureaus of Chemistry and Plant Industry and tested out in the field on potatoes, tomatoes, and other crops in collaboration with various offices of the Bureau of Plant Industry. Chemical examinations will be made of the various parts of the plant for copper, and the yield and composition of the crops will be determined. The Bureau of Plant Industry will study the effect of these sprays on the physiological activities of the potato and other plants.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Washington, D. C., Presque Isle, Me., and various points in the field where the Bureau of Plant Industry is carrying on spraying experiments.

*Date begun.*—1918.

*Assignment.*—F. C. Cook, J. K. Haywood, C. C. McDonnell.

*Proposed expenditures, 1918-19.*—\$600.

**Investigation of the Chemical Composition, Properties, and Manufacture of Arsenical Insecticides and Physiological Effect of These Compounds on Insects:**

*Object.*—To study the composition and chemical and physical properties of various arsenicals, the raw materials used in preparing them, and the methods of preparation; to investigate the physiological effects of these compounds on insects, with a view to obtain data on the amounts of arsenic in various forms needed to kill various insects and the mode of action of these substances on insects, and as a guide in the preparation of new and more effective arsenical insecticides; also to secure full data relative to just what the various arsenicals are, how they differ chemically, and how they are prepared.

*Procedure.*—The chemical and physical work will be performed by the Bureau of Chemistry. The Bureau of Entomology will cooperate by conducting the physiological work. Various arsenicals will be chemically examined and information collated from the literature on the subject. Methods of manufacturing and preparing arsenicals will also be studied. Arsenicals of known composition and new arsenicals will be prepared by the Bureau of Chemistry and furnished to the Bureau of Entomology for practical field tests. The latter bureau will study the action of the various arsenicals on insects and, when necessary, will test the preparations on a commercial scale, in collaboration with the Bureau of Chemistry.

*Cooperation.*—Bureau of Entomology.

*Location.*—Washington, D. C., and various points in the field where the Bureau of Entomology is conducting spraying experiments.

*Date begun.*—1918.

*Assignment.*—F. C. Cook, J. K. Haywood, C. C. McDonnell.

*Proposed expenditures, 1918-19.*—\$2,650.

**Investigation of the Chemical Composition, Synthesis, and Chemical Modification of the Active Insecticidal Principles of Plants and Action of Same on Insects:**

*Object.*—To determine the active insecticidal principles of plants and the chemical and insecticidal properties of same; to determine whether compounds corresponding to active constituents of plants can be prepared synthetically which will have insecticidal action; and to develop new insecticides.

*Procedure.*—Plants showing insecticidal action will be submitted to chemical examination with a view to identify the insecticidal principle. They



will also be examined by a microscopist to determine their histological characteristics, in order that they may be identified when used in commercial insecticides. Promising active ingredients of plants and other materials will be separated, studied chemically, and prepared synthetically by the Bureau of Chemistry, and the Bureau of Entomology will conduct tests of these substances on insects. The Bureau of Plant Industry will be consulted relative to promising plants to study.

*Cooperation.*—The Bureau of Chemistry will perform all chemical and microscopic work on plants and prepare synthetic insecticides. The Bureau of Entomology will perform all practical experiments on insects, including tests to determine the action of the products, both as contact and stomach poisons. The Bureau of Plant Industry will advise relative to plants to be studied and will test the action of active principles and synthetic chemicals on vegetation.

*Location.*—Chemical, microscopic, and testing work at Washington, D. C.; and various field stations of the Bureaus of Plant Industry and Entomology.

*Date begun.*—1918.

*Assignment.*—J. K. Haywood, C. C. McDonnell, F. E. La Forge.

*Proposed expenditures, 1918-19.*—\$2,250.

### **Investigation of the Preparation of Commercial Insecticides and Fungicides and of Their Properties.**

*Object.*—To determine cheap and effective methods of preparing insecticides and fungicides.

*Procedure.*—Commercial methods of preparing insecticides and fungicides will be studied under practical conditions of preparation. Tests of the efficacy of these materials, their injury to vegetation, and their general practicability under field conditions will be made in collaboration with the Bureaus of Entomology and Plant Industry.

*Cooperation.*—Bureaus of Plant Industry and Entomology.

*Location.*—Washington, D. C., and various factories in the United States.

*Date begun.*—1918.

*Assignment.*—J. K. Haywood, C. C. McDonnell.

*Proposed expenditures, 1918-19.*—\$13,500.

**Total, Insecticide and Fungicide Investigations, \$25,000.**

[Research.]

### **DEHYDRATION OF VEGETABLES, FRUITS, AND OTHER PERISHABLE EDIBLE PRODUCTS.**

#### **Dehydration of Vegetables, Fruits, and Other Perishable Edible Products:**

*Object.*—To establish a dehydration industry on a scientific basis.

*Procedure.*—Comparative studies on dehydration as now practiced will be made, the methods and underlying principles investigated, and the finished product examined and analyzed. A campaign to instruct the consuming public in the use, availability, and food value of these products will be undertaken.

*Cooperation.*—Cooperative arrangements will be made with leading manufacturers whereby bureau representatives will be detailed to study operations, aid given in the development of processes, and assistance rendered in establishing a demand for the finished product.

*Location.*—Washington, D. C., and various points in the field where plants are located.

*Date begun.*—1918.

*Assignment.*—S. C. Prescott, L. D. Sweet.

*Proposed expenditures, 1918-19.*—\$250,000.



## BUREAU OF SOILS.

### GENERAL ADMINISTRATION.

#### Office of Chief of Bureau:

*Object.*—General administration, supervision, and direction of the activities and operations of the bureau.

*Cooperation.*—Other bureaus of the department, other departments, and State institutions.

*Location.*—Washington, D. C.

*Date begun.*—1894.

*Assignment.*—Milton Whitney.

*Proposed expenditures, 1918-19.*—\$5,600.

#### Office of Chief Clerk:

*Object.*—The chief clerk is charged with carrying out the directions and policies of the chief of bureau as these relate to supervision and control of the clerical work, including the handling of correspondence and mail, stenographic and messenger service, and property and supplies.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—A. G. Rice.

*Proposed expenditures, 1918-19.*—\$16,260.

#### Accounts:

*Object.*—To supervise and keep proper records of all financial operations of the bureau, issue purchase requisitions, make administrative examinations of all accounts, and prepare travel authorizations, pay rolls, estimates, and such financial reports as may be required from time to time.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—C. A. Wolfe.

*Proposed expenditures, 1918-19.*—\$4,400.

#### Editorial Work:

*Object.*—To read for the chief of bureau all manuscripts submitted for publication, edit or rewrite such manuscripts as may be necessary to bring them into harmony with the bureau's policy, compile data for use of the soil-survey field men, read and correct proof, and assist in the preparation of specifications for the lithographic reproduction of maps and in the proofreading of the same.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—Chas. H. Seaton.

*Proposed expenditures, 1918-19.*—\$7,000.

#### Supplies:

*Object.*—To supervise and distribute all supplies and equipment purchased for field, laboratory, and office use and record the same.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—W. H. Young.

*Proposed expenditures, 1918-19.*—\$6,400.

#### Files and Records:

*Object.*—To index and file all correspondence pertaining to the operations of the bureau.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—H. A. Donovan.

*Proposed expenditures, 1918-19.*—\$2,600.

**Total, General Administration, \$42,260, including \$38,260 statutory.**



## [Research.]

## SOIL CHEMICAL INVESTIGATIONS.

**Supervision:**

*Object.*—To direct the chemical investigations of soils and to supervise the routine laboratory and clerical work necessary for the proper conduct of these activities.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—Leader to be appointed.

*Proposed expenditures, 1918-19.*—\$2,500.

**Mineral Nature of Agriculturally Important American Soils:**

*Object.*—To determine the predominating minerals or those which characterize soil types, with a view to establish the origin, process of formation, and relations of these types.

*Procedure.*—Application of petrographic methods as outlined in Bureau of Soils Bulletin 91 or new methods devised for the purpose.

*Location.*—Washington, D. C.

*Date begun.*—1908.

*Results.*—The mineral composition of a large number of samples of virgin soils has been determined; also the variation in mineral composition of soils of several types.

*Assignment.*—W. H. Fry.

*Proposed expenditures, 1918-19.*—\$1,500.

**Routine Microscopic Work:**

*Object.*—Determination of the identity of rocks and other soil-forming and fertilizer-producing materials submitted by the various divisions of this bureau and by other institutions.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—The identity of a large number of samples of minerals and miscellaneous materials has been determined.

*Assignment.*—W. H. Fry.

*Proposed expenditures, 1918-19.*—\$700.

**(Absorption by Soils:** Discontinued as a separate project; included under "Liming of Soils.")

**(Lime-Phosphate Investigations:** Discontinued as a separate project; included under "Inorganic Composition of Soils.")

**Inorganic Composition of Soils:**

*Object.*—To determine the inorganic chemical composition of important soil types of the United States.

*Procedure.*—The collection of large samples from surveyed areas by field men familiar with the type, with careful handling to prevent contamination, followed by careful laboratory analyses of the sample.

*Location.*—Washington, D. C., and field assignments.

*Date begun.*—1911.

*Results.*—Determination of the inorganic composition of a large number of samples of virgin soils has been completed; also the composition of two soil types and a large number of miscellaneous soil samples.

*Assignment.*—L. A. Steinkoenig, William Hazen, H. P. Magnuson, John G. Fairchild.

*Proposed expenditures, 1918-19.*—\$8,000.

**(Ash Composition of Important Crop Plants:** Project completed. The purpose of this investigation was to determine what elements found in soils are present in plant ash. Analyses of 48 samples of crop plants for all elements for which methods were available have been completed and the results published in Department Bulletin 600, "The Relation of Some of the Rarer Elements in Soils.")

**Hydolytic Decomposition of Soil-Forming Minerals:**

*Object.*—To study the action of water and such substances as may exist in the soil solution upon the decomposition and degradation of soil minerals and the possible synthesis of new mineral species.

*Procedure.*—The work involves chemical studies of hydrolysis products when water or solutions of salts act on minerals; chemical and micro-



scopic studies of residues; studies of solutions yielded by soil minerals under controlled conditions; field investigations as to changes in minerals from solid rock to soil.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—The hydrolyzing effect of solutions of various salts on some soil minerals has been determined and results obtained which throw additional light on the effect of fertilizing salts on the soil.

*Assignment.*—R. F. Gardiner.

*Proposed expenditures, 1918-19.*—\$1,500.

#### **Routine Laboratory Analyses:**

*Object.*—To make chemical analyses of soils, waters, and related materials for this bureau and other bureaus of the department.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—Analyses have been made of a large number of samples of soils, alkali crusts, waters, limestones, marls, etc., for other bureaus of the department and other departments.

*Assignment.*—W. B. Pope, H. P. Magnuson, John G. Fairchild.

*Proposed expenditures, 1918-19.*—\$6,000.

**(Study of Analytical Data Relative to Soil Productivity: Discontinued as a separate project; included under "Inorganic Composition of Soils.")**

#### **Liming of Soils:**

*Object.*—To study the effects of liming and determine a proper basis for the practice of liming soils.

*Procedure.*—The physicochemical changes produced in soil by liming are investigated by laboratory methods. Biological changes are not studied specifically, but it is planned, when the laboratory studies have been developed to the point where the results can be utilized in field investigations, to seek the assistance of the Bureau of Plant Industry and State organizations.

*Location.*—Washington, D. C., and field assignments.

*Date begun.*—1914.

*Results.*—The study of the calcium compound in soils was continued and additional information obtained regarding the solubility of calcium silicates. The solubility and distribution of different forms of lime has been determined with one soil type. A study has been made of the absorption of lime in several soil types and the results prepared for publication.

*Assignment.*—J. G. Smith, William Hazen, M. S. Anderson.

*Proposed expenditures, 1918-19.*—\$6,250.

**Total, Soil Chemical Investigations, \$26,450, including \$840 statutory.**

[Research.]

### **SOIL PHYSICAL INVESTIGATIONS.**

#### **Supervision:**

*Object.*—To direct the physical investigations of soils and to supervise the routine laboratory and clerical work necessary to their proper conduct.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Assignment.*—R. O. E. Davis.

*Proposed expenditures, 1918-19.*—\$3,000.

#### **Designing, Construction, and Standardization of Instruments:**

*Object.*—To assist the activities of the bureau by furnishing or standardizing physical instruments.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—Several instruments of general utility have been developed. Assistance has been rendered other activities in construction of apparatus not obtainable on the market.

*Assignment.*—J. B. Kershaw.

*Proposed expenditures, 1918-19.*—\$2,965.



**Physical Examination of Soils:**

*Object.*—To determine quantitatively the mechanical separates for an expression of the textural characteristics of soils; to investigate the physical composition of soils; to determine the relation of the different components to the physical condition of the soil; and to study the physical properties of various types of agricultural soils.

*Procedure.*—Mechanical analyses are made according to the methods outlined in Bureau of Soils Bulletin 84. The various-sized particles composing the soils are separated by centrifuging, sedimentation, and filtration and the physical properties of the separates studied. Especial attention is given to the smallest sized particles and the portions separated by filtration. As some of these often are present only in small amounts, the analysis may involve the handling of large quantities of soil. Physical properties of soil types are measured to assist in the correlation of the various soils.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—Methods of mechanical analyses of soils have been devised and apparatus for carrying out such analyses designed and constructed. Sample of soils collected by the soil survey have been examined and classified. A study of the colloidal properties of the fine soil particles has been made. Classification by centrifuging and sedimentation has been investigated.

*Assignment.*—L. B. Olmstead.

*Proposed expenditures, 1918-19.*—\$5,800.

**Soil Stresses and Strains:**

*Object.*—To study the magnitude and direction of stresses in the soil induced by changes in moisture content or by the application of loads on the soil, and to determine the relative movement of large and small particles under fluctuating moisture conditions.

*Procedure.*—Measurements are made in the laboratory of stresses produced by the wetting of dry soils at minimum volume. Effects of adding various soil separates and colloidal material are observed. Relative rates and direction of movement of soil particles are measured.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—"Natural packing" has been explained; the interchange of soil and subsoil material shown to be continuous; and methods for observation and measurement of these movements and stresses devised. A study of the change in stresses induced by changing the mechanical composition of soils has been made.

*Assignment.*—L. B. Olmstead.

*Proposed expenditures, 1918-19.*—\$400.

**Soil Erosion:**

*Object.*—To investigate the causes of excessive soil erosion and determine the best methods for the control and prevention of erosion in soils of different types and under various climatic and crop conditions.

*Procedure.*—Field examinations are to be made of existing conditions, supplemented by laboratory examinations of soils.

*Location.*—Washington, D. C., and field assignments.

*Date begun.*—1913.

*Results.*—The various types of erosion in Southern and Pacific Coast States have been observed, causes investigated, and preventive and remedial methods critically examined. Publications issued: "Soil Erosion in the South," Department Bulletin 180; "The Economic Waste from Soil Erosion," Department Yearbook, 1913. A study has been made of the physical properties of additional soils subject to erosion. This has consisted mainly of comparison of the mechanical composition, the optimum water content, and water-holding capacity.

*Assignment.*—R. O. E. Davis.

*Proposed expenditures, 1918-19.*—\$500.

**Movement of the Soil Solution:**

*Object.*—To investigate the relations of soil texture, temperature, and composition to the movement of soil solution, with a view to determine the



general laws of distribution of soil moisture; to devise electrical or other instruments for estimating the moisture content of soils.

*Procedure.*—The movement of the soil solution within the soil is determined by the study of the moisture equilibrium in different layers of soil. Search is made for some physical property of soils which bears a quantitatively measurable relation to the moisture content.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—General laws have been deduced and verified by experiment. Methods for the determination of the critical moisture content of soils have been devised and data collected on the distribution of moisture in the soil. Efforts to devise an instrument of general utility for soil-moisture determinations have been continued.

*Assignment.*—R. O. E. Davis, L. B. Olmstead.

*Proposed expenditures, 1918-19.*—\$800.

### **Absorption by Soils:**

*Object.*—To determine the effect of various substances upon salts in the fixation of fertilizer constituents by soils, and to study the underlying causes of the presence of gases and other substances in the soil solution.

*Procedure.*—By subjecting samples of soil material to high vacuum and then subjecting them to atmospheres saturated with gaseous substances, the character and amount of absorption are observed.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—General laws have been deduced in connection with the chemical investigations. The absorption of water vapor by soil has been studied under conditions of control for temperature and vapor pressure.

*Assignment.*—L. H. Greathouse.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

### **Soil Temperatures:**

*Object.*—To investigate heat conductance of soils and the relation of temperature changes and of solar radiation to soil conditions.

*Procedure.*—Complete continuous records of temperature changes at various depths of soil under different soil conditions, as well as of solar and sky radiation, are obtained.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Cooperation.*—Weather Bureau, which furnishes records of solar radiation at regular intervals.

*Date begun.*—1901.

*Results.*—General laws of heat conductance in the soil as influenced by texture and moisture content have been investigated. The effect of freezing on soil has been investigated, especial attention being paid to the changes in soil solution and mechanical composition induced thereby.

*Assignment.*—R. O. E. Davis, L. B. Olmstead.

*Proposed expenditures, 1918-19.*—\$1,800.

### **Soil Aeration:**

*Object.*—To investigate the changing conditions of soil atmosphere and their effect on productivity.

*Procedure.*—A study is made of the composition of soil atmosphere and its movements as influenced by barometric pressure, temperature, texture, and tillage.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—Observations on the absorption and retention of carbon dioxide by soils have been made and general laws for movement of soil atmosphere deduced from theoretical and experimental grounds. The change in composition of soil atmosphere due to differences in mechanical composition has been investigated. Activity has been largely suspended on account of cooperation with the Division of Fertilizer Resources.

*Assignment.*—L. H. Greathouse.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

**Total, Soil Physical Investigations, \$15,265, including \$3,040 statutory.**



[Research.]

## INVESTIGATIONS OF FERTILIZER RESOURCES.

**Supervision:**

*Object.*—To direct the investigations of the fertilizer resources of the United States and to supervise the routine laboratory and clerical work necessary for their proper conduct.

*Location.*—Washington, D. C.

*Date begun.*—1911.

*Assignment.*—Frederick W. Brown.

*Proposed expenditures, 1918-19.*—\$4,200.

**Extraction of Potash Salts from Kelp:**

*Object.*—To investigate and demonstrate on a commercial scale the practicability and economic value of various methods of extracting potash salts from kelp.

*Procedure.*—A plant has been erected and is being operated on the Pacific coast to experiment on a commercial scale with various processes for recovering potash from kelp and to demonstrate whether or not, under normal conditions, potash can be recovered from this source in competition with potash from other sources. With the appropriation available it is proposed to proceed with this project on a scale that will furnish accurate cost data for commercial practice.

*Cooperation.*—Manufacturers of potash from kelp.

*Location.*—Washington, D. C., and Summerland, Cal.

*Date begun.*—1913.

*Results.*—Laboratory work has been carried on both with flocculation of green kelp and with carbonization of dried kelp, the presence of potash in kelp shown, beds surveyed and charted, many analyses of kelp made, and experiments conducted with several methods of extraction. An experimental plant has been erected at Summerland, Santa Barbara County, Cal., and has been in partial operation since the later part of 1917. Dried kelp and kelp ash have been produced in considerable quantities and sold for fertilizer purposes at prevailing market prices.

*Assignment.*—Frederick W. Brown, J. W. Turrentine, E. B. Smith.

*Proposed expenditures, 1918-19.*—\$127,600.

**Effect of Harvesting and Other Factors on the Growth of Kelp:**

*Object.*—To determine the effect of different methods of harvesting on the growing of kelp.

*Location.*—La Jolla and other California coast points.

*Date begun.*—1912.

*Results.*—It has been shown that harvesting kelp under certain conditions induces increased growth, that fresh-water streams have little influence on the beds, and that storms frequently destroy the beds temporarily. Reports have been prepared on commercial plants now operating on the beds.

*Assignment.*—W. C. Crandall.

*Proposed expenditures, 1918-19.*—\$400.

**Production of Potash from Feldspar and Other Mineral Sources:**

*Object.*—To determine commercially possible methods for utilizing feldspar, alunite, natural brines, etc., as sources of potash for fertilizer production.

*Procedure.*—The practicability of recovering potash from mineral sources is being investigated by various laboratory methods.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1912.

*Results.*—Preliminary work on the extraction of potash from salt-lake brines has been carried on. Experiments have shown that it is possible, when operating according to the procedure outlined, to completely volatilize the potash from feldspar at the temperatures used in cement manufacture and that the residue obtained has the composition required for Portland cement. Experiments have also shown that when feldspar and lime in proper proportions for cement are treated under pressure about 95 per cent of the potash content is rendered soluble as caustic potash. A complete survey of the cement industry of the United States and



Canada was made, showing the amount of potash now being volatilized and lost in that industry.

A survey of the blast-furnace industry to show the amount of potash being volatilized and lost in that industry has been carried on and will be continued during the present year.

*Assignment.*—W. H. Ross, A. R. Merz, T. R. LeCompte.

*Proposed expenditures, 1918-19.*—\$3,000.

#### **Fertilizer Value of City and Trade Wastes:**

*Object.*—To determine the amount and value of city and trade wastes as sources of commercial fertilizer material.

*Procedure.*—Inspections of various municipal disposal plants are made, samples collected and analyzed, and a study of practical methods of utilizing city and industrial wastes undertaken.

*Cooperation.*—Municipal officers of various cities.

*Location.*—Washington, D. C., Arlington Farm, Va., and field assignments.

*Date begun.*—1913.

*Results.*—A new method of rendering garbage has been devised and tested on a laboratory scale with most promising results, and a large amount of data on city and trade wastes has been collected and published in chemical journals. The more important garbage-disposal plants in the country have been visited and data for comparing the relative value of different processes collected. An investigation of the garbage of Washington, D. C., was made in cooperation with the municipal authorities to determine the most economical methods of disposal and utilization.

*Assignment.*—J. W. Turrentine, A. R. Merz.

*Proposed expenditures, 1918-19.*—\$2,250.

#### **Fertilizer Value of Nitrogenous Materials:**

*Object.*—To determine the actual fertilizer value, by chemical and other methods, of various nitrogenous materials.

*Procedure.*—The various nitrogenous fertilizer materials are subjected to analysis in the laboratory by the several conventional analytical methods and the relative availability of their nitrogen studied, special attention being given to the effect of soil types on availability. The effect on availability of the various commercial methods of processing is also studied.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1914.

*Results.*—Various nitrogenous fertilizer materials have been subjected to different methods of analysis, and several papers suggesting a new method have been prepared and published. The work on the nitrogen availability of various organic materials has been continued and special attention given to the utilization of peat as a fertilizer material.

*Assignment.*—J. W. Turrentine.

*Proposed expenditures, 1918-19.*—\$2,000.

#### **Fixation of Nitrogen by Catalytic Processes:**

*Object.*—To investigate methods of fixing nitrogen by the aid of catalytic reagents, with a view to increase the efficiency of known methods and to devise new ones.

*Procedure.*—Laboratory experiments are made to test the comparative merits of different methods, their relative efficiency, and their efficiency as compared with other methods of nitrogen fixation.

*Cooperation.*—War Department.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1916.

*Results.*—The Ostwald process of oxidizing ammonia was investigated in the Arlington laboratory, and, in cooperation with the War Department, the Bureau of Mines, and a chemical manufacturing company, a study of the oxidation of ammonia to nitric acid has been carried on on a commercial scale at Solvay, N. Y.

Apparatus for the production of synthetic ammonia by the Haber process has been installed and operated during the latter part of the year. These investigations will be continued with the object of determining the most efficient catalyzer for use in this process.

*Assignment.*—R. O. E. Davis, H. Bryan.

*Proposed expenditure, 1918-19.*—\$4,700.



### Fixation of Atmospheric Nitrogen:

*Object.*—To investigate new processes of fixing nitrogen by reduction methods.

*Procedure.*—Studies are made of various methods of fixing atmospheric nitrogen by means of electrical energy, with a view to determine the best methods for use under American conditions, improve known methods, and devise new ones.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1913.

*Results.*—An electric furnace with absorption tower has been installed at the Arlington Farm, and numerous experimental runs have been made. Results of preliminary experiments (Journal of Industrial and Engineering Chemistry, vol. 5) have shown that the potash in feldspar can be completely volatilized when treated according to the procedure outlined and that fixation of considerable nitrogen takes place in the residue at the same time.

A study of the electrolytic oxidation of ammonia has been carried on in cooperation with the Bureau of Ordnance of the War Department and preliminary studies of several proposed methods for nitrogen fixation and for the oxidation of ammonia made. This work will be continued during the present year.

*Assignment.*—W. H. Ross, J. N. Carothers, L. H. Greathouse.

*Proposed expenditures, 1918-19.*—\$6,400.

### Extraction of Phosphoric Acid from Natural Phosphates:

*Object.*—To compare the sulphuric-acid and electrical methods of extracting phosphoric acid from natural phosphates and to devise improvements in these methods.

*Procedure.*—This work involves a study of the volatilization of phosphoric acid from phosphate rock by electrical and other forms of heat energy, a comparison of the efficiency of methods devised with the sulphuric-acid method or improvements in the latter method, and an investigation of the most economical methods of separating phosphoric acid from solution.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1913.

*Results.*—A possible improvement in the sulphuric-acid method for preparing phosphoric acid has been devised, and an investigation has been made of a method of separating phosphoric acid from solution, as obtained in either the sulphuric-acid or electrical methods, by precipitating it by means of ammonia in the form of ammonium phosphate.

The volatilization of phosphate rock in the electric furnace and the collection of the fumes by electrical precipitation has been demonstrated on a semicommercial scale at the Arlington laboratory and on a commercial scale in cooperation with a manufacturing company at Hoboken, N. J. Cost data on the process have been secured and published. A furnace designed to use oil fuel has been erected and preliminary experiments conducted with the object of volatilizing phosphoric acid in phosphate rock much more cheaply than by the use of electric power. This work will be continued.

*Assignment.*—W. H. Waggaman.

*Proposed expenditures, 1918-19.*—\$4,000.

### Phosphate Industry of the United States:

*Object.*—To investigate the sources, quantity, and production of phosphate rock, its manipulation for the fertilizer industry, the relative merits of the products obtained by the several manipulations, and other factors necessary to determine the cost to the farmer and to inform him concerning changing conditions.

*Procedure.*—Consultation with manufacturers and consumers of phosphate-carrying materials by correspondence and in person; visiting and consulting officials of State colleges and experiment stations and conducting laboratory investigations in Washington, with a view to ascertain the availability and fertilizer value of finely ground raw phosphate rock and other forms of phosphate fertilizer.

*Location.*—Washington, D. C., and field assignments.

*Date begun.*—1911.

*Results.*—An investigation of the methods of manufacturing phosphate fertilizers has been made and a publication on this subject issued; an im-



proved method of producing sulphuric acid for use in manufacturing superphosphates devised and published; and the fertilizer value of ground phosphate rock investigated. Statistics on phosphate deposits, production, and consumption have been collected for some years; reports on the deposits of Tennessee, Kentucky, Arkansas, and South Carolina published; investigations made with a view to render the slag produced by iron and steel furnaces available for fertilizer purposes, and methods for utilizing this waste suggested in two publications. A summary of conditions during the past year has been published.

*Assignment.*—W. H. Waggaman.

*Proposed expenditures, 1918-19.*—\$2,750.

### **Concentration of Low-Grade Phosphates:**

*Object.*—To determine economical methods of extracting phosphoric acid from the waste material resulting from mining operations.

*Procedure.*—Mechanical and chemical methods of separating phosphoric acid from impurities with which it is associated in the material at present discharged on the waste heaps are followed.

*Location.*—Washington, D. C., and field assignments.

*Date begun.*—1913.

*Results.*—Some preliminary results have been obtained from the treatment of hard rock-phosphate waste which show that a partial separation of the phosphoric acid is mechanically practicable. Studies on a semicommercial scale have shown the possibility of the use of mine-run material in the electric furnace. This work is being continued, using other sources of heating than electrical energy in the effort to cheapen the process.

*Assignment.*—W. H. Waggaman.

*Proposed expenditures, 1918-19.*—\$3,400.

### **Production of Concentrated Fertilizer Products:**

*Object.*—To investigate the possibility of producing combinations of nitrogen, phosphorus, and potash, or combinations of any two of these elements, by methods which may make it possible to use such compounds for fertilizer purposes.

*Procedure.*—Laboratory experimentation is carried on with various methods of combining or mixing the elements ordinarily used for fertilizers, and the more promising of these methods will be tried out on a somewhat larger scale.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1915.

*Results.*—Several very promising methods for producing compounds of the fertilizer elements have been worked out in the laboratory, and apparatus is now being installed to try these methods out on a larger scale.

*Assignment.*—W. H. Ross, A. R. Merz, J. N. Carothers.

*Proposed expenditures, 1918-19.*—\$1,500.

### **Production of Raw Materials Suitable for Fertilizer Purposes:**

*Object.*—To obtain accurate and authentic data, by correspondence with producers and by occasional visits to mines and factories, regarding available or partially available fertilizer resources.

*Cooperation.*—Miners and manufacturers.

*Location.*—Washington, D. C., and field assignments.

*Date begun.*—1912.

*Results.*—A trip was made to several large cities to secure data on the supply, value, and distribution of stable manure. Summaries of available raw materials have been made and kept up to date. Several publications on stable manure have been issued, and an additional bulletin on this subject is in preparation.

*Assignment.*—C. C. Fletcher.

*Proposed expenditures, 1918-19.*—\$1,600.

### **Analyses of Samples:**

*Object.*—To examine samples of materials which give promise of value for fertilizer use.

*Procedure.*—Laboratory examination is made of samples submitted by private individuals or secured through the field force of the bureau.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date begun.*—1911.



*Results.*—A large number of samples have been analyzed, furnishing to the various subactivities of the bureau and outside organizations and individuals chemical data relative to the fertilizer value of the materials examined. The information so disseminated has led to the utilization of supplies of fertilizer materials not hitherto used and has undoubtedly prevented the expenditure of large sums of private capital in the attempted exploitation of materials that have no value as fertilizer.

*Assignment.*—J. W. Bomboy.

*Proposed expenditures, 1918-19.*—\$1,500.

**Total, Investigations of Fertilizer Resources, \$165,300, including \$6,360 statutory.**

[Research.]

## SOIL-SURVEY INVESTIGATIONS.

### Supervision:

*Object.*—To plan and direct the soil-survey investigations and to conduct correspondence and supervise general office work in connection therewith.

*Cooperation.*—Other bureaus of the department and State organizations.

*Location.*—Washington, D. C.

*Date begun.*—1898.

*Assignment.*—Curtis F. Marbut.

*Proposed expenditures, 1918-19.*—\$15,010.

### Soil Surveys—Detail and Reconnoissance:

*Object.*—This work comprises the surveying, mapping, and classifying of the soils of important areas in different parts of the country; the preparation of reports containing descriptive matter relating to the soils, their character, origin, and value for crops, and to the agricultural conditions found in each area surveyed; the preparation of maps showing the distribution of the soils; and the dissemination of information relating to the use of soils. The purpose is to acquire a knowledge of the soils of the United States and make it available for use by other bureaus and departments, agricultural colleges, experiment stations, and others engaged in the development of agricultural interests.

*Results.*—The following areas were completed during the fiscal year 1918:

Alabama: Morgan County.

Arizona: Gila Valley area.

California: El Centro area.

Florida: Flagler County.

Georgia: Floyd, Early, Pierce, and Pulaski Counties.

Idaho: Nez Perce and Lewis Counties.

Indiana: Adams and Lake Counties.

Iowa: Blackhawk, Buena Vista, Hamilton, Henry, Linn, Montgomery, and Wapello Counties.

Louisiana: La Salle Parish.

Maine: Caribou area.

Maryland: Baltimore and Washington Counties.

Mississippi: Pearl River and Pike Counties.

Missouri: Knox, Lincoln, and Texas Counties.

Nebraska: Chase, Morrill, Phelps, and Wayne Counties.

New Jersey: Belvidere and Millville areas.

New York: Oswego and Saratoga Counties.

North Carolina: Beaufort, Bertie, Caldwell, Orange, and Hoke Counties.

North Dakota: Sargent County.

Ohio: Mahoning and Sandusky Counties.

Oklahoma: Canadian County.

Oregon: Yamhill County.

Pennsylvania: Mercer County.

South Carolina: Horry and Newberry Counties.

Tennessee: Maury County.

Texas: Bowie County.

Virginia: Accomac and Northampton Counties.

Washington: Spokane County.

West Virginia: Barbour and Upshur Counties.

Wisconsin: Rock and Waupaca Counties.

Wyoming: Fort Laramie area.

*Work planned.*—The areas approved by the Secretary for survey during the summer of 1918 are as follows:



## SOIL SURVEY—DETAIL AREAS.

Location.	Cooperation.	Probable date of completion.	Assignment.	Proposed expenditures, 1918-19.
Grass Valley, Cal.....	University of California and California Agricultural Experiment Station.	October, 1918....	E. B. Watson <sup>1</sup> .....	\$1,000
Kent County, Del.....	Delaware Agricultural Experiment Station.	December, 1918..	J. E. Dunn <sup>1</sup> .....	1,800
Madison County, Ga...	Georgia College of Agriculture.	.....do.....	State men.....	<sup>2</sup> None.
Bannock County, Idaho	Idaho Agricultural Experiment Station.	January, 1919...	H. G. Lewis <sup>1</sup> .....	1,900
Louisa County, Iowa...	Iowa Agricultural Experiment Station.	December, 1918..	L. V. Davis <sup>1</sup> .....	1,600
Madison County, Iowa.	.....do.....	.....do.....	E. H. Smies <sup>1</sup> .....	1,800
Marshall County, Iowa.	.....do.....	.....do.....	R. T. A. Burke <sup>1</sup> .....	1,900
Palo Alto County, Iowa	.....do.....	.....do.....	A. M. O'Neal, jr. <sup>1</sup> ...	1,800
Polk County, Iowa.....	.....do.....	.....do.....	State men.....	1,200
Wayne County, Iowa...	.....do.....	.....do.....	C. Lounsberry <sup>1</sup> .....	1,900
Winnebago County, Iowa.	.....do.....	November, 1918.	W. E. Tharp <sup>1</sup> .....	1,600
Logan County, Ky.....	Kentucky Agricultural Experiment Station.	.....do.....	L. R. Schoenmann <sup>1</sup> ..	1,700
Highmoor area, Me.....	Bureau of Plant Industry	.....do.....	L. A. Hurst, E. W. Knobel.	1,900
Carroll County, Md....	Maryland Geological Survey and Maryland Agricultural Experiment Station.	December, 1918..	E. B. Deeter <sup>1</sup> .....	1,800
Charles County, Md....	.....do.....	.....do.....	H. C. Smith <sup>1</sup> .....	2,000
Stevens County, Minn..	Minnesota Agricultural Experiment Station.	November, 1918.	R. F. Rogers <sup>1</sup> .....	1,500
Choctaw County, Miss..	Mississippi Geological Survey.	.....do.....	A. C. Anderson <sup>1</sup> ....	1,700
Chariton County, Mo...	University of Missouri and Missouri Agricultural Experiment Station.	January, 1919...	W. I. Watkins <sup>1</sup> , C. E. Deardorff <sup>1</sup> ..	2,300
Reynolds County, Mo...	.....do.....	November, 1918.	W. I. Watkins <sup>1</sup> , C. E. Deardorff.	1,400
Cheyenne County, Nebr.	University of Nebraska	December, 1918..	F. A. Hayes <sup>1</sup> , E. C. Hall.	3,100
Sheridan County, Nebr.	.....do.....	January, 1919...	W. B. Tillman <sup>1</sup> .....	1,900
Barneget area, N. J....	New Jersey Geological Survey and New Jersey Agricultural Experiment Station.	November, 1919.	A. L. Patrick <sup>1</sup> .....	1,900
Somerville area, N. J..	.....do.....	.....do.....	A. L. Patrick <sup>1</sup> .....	1,900
Chenango County, N. Y.	New York State College of Agriculture.	January, 1919...	C. VanDuyne <sup>1</sup> .....	1,900
Westchester County, N. Y.	.....do.....	December, 1918..	E. T. Maxon.....	1,800
Vance County, N. C....	North Carolina Department of Agriculture.	November, 1918.	E. S. Vanatta <sup>1</sup> .....	1,600
Wilkes County, N. C....	.....do.....	.....do.....	R. C. Jurney <sup>1</sup> .....	1,400
Trail County, N. Dak..	North Dakota Agricultural Experiment Station.	January, 1919...	F. Z. Hutton <sup>1</sup> .....	1,900
Fulton County, Ohio...	Ohio Agricultural Experiment Station.	December, 1918..	G. B. Jones <sup>1</sup> .....	1,700
Wayne County, Ohio...	.....do.....	November, 1918.	S. W. Phillips <sup>1</sup> .....	1,400
Washington County, Oreg.	Oregon Agricultural Experiment Station.	January, 1919...	E. C. Eckmann <sup>1</sup> ....	2,300
Meigs County, Tenn....	Tennessee Geological Survey	December, 1918.	J. H. Agee <sup>1</sup> .....	1,400
Denton County, Tex...	Texas Agricultural Experiment Station.	September, 1918.	W. T. Carter, jr., <sup>1</sup> ..	1,600
Freestone County, Tex.	.....do.....	November, 1918.	M. W. Beck.	
Pittsylvania County, Va.	Virginia Geological Survey..	December, 1918.	H. W. Hawker <sup>1</sup> ....	1,800
Chelan area, Wash.....	Washington Geological Survey and Washington Agricultural Experiment Station.	.....do.....	N. M. Kirk <sup>1</sup> .....	1,700
Braxton and Clay Counties, W. Va.	West Virginia Geological Survey.	.....do.....	A. E. Kocher <sup>1</sup> .....	2,300
Webster County, W. Va	.....do.....	.....do.....	W. J. Latimer <sup>2</sup> .....	900
Adams County, Wis...	Wisconsin Geological and Natural History Survey.	.....do.....	C. N. Mooney <sup>2</sup> .....	900
Jackson County, Wis...	.....do.....	.....do.....	A. H. Meyer <sup>1</sup> .....	1,700
Kenosha County, Wis...	.....do.....	November, 1918.	G. W. Musgrave <sup>1</sup> ...	1,500
Outagamie County, Wis.	.....do.....	.....do.....	A. E. Taylor <sup>1</sup> .....	1,700
Winter and spring assignments, to be determined later.	.....do.....	October, 1918....	State men.....	700
				69,800
				94,050
				163,850

<sup>1</sup> Assisted by State representatives.<sup>2</sup> Expenses paid by State.



**Inspection of Field Work:**

*Object.*—To inspect all work of the soil-survey field parties, examine and correct area reports, and prepare memoranda for soil correlation.

*Location.*—Headquarters, Washington, D. C.; much time is spent in the field in inspection work.

*Date begun.*—1898.

*Results.*—All areas surveyed during the past year have been inspected, reports corrected, and correlation memoranda prepared.

*Assignment.*—H. H. Bennett, W. E. Hearn, M. H. Lapham, W. E. McLendon, T. D. Rice.

*Proposed expenditures, 1918-19.*—\$18,750.

**Map Drafting:**

*Object.*—Preparation of soil (both detail and reconnoissance), alkali, and land-classification maps; also page-plate illustrations; and securing map data in advance for field use.

*Cooperation.*—Other bureaus of the department and other departments.

*Location.*—Washington, D. C.

*Date begun.*—1898.

*Results.*—Base and soil maps have been prepared; miscellaneous data for field and office use secured; traverse adjusted; Land Office work and railroad and river surveys plotted; maps to be used as copy in lithographic reproduction compiled, redrawn, and colored from original field sheets and from notes of soil-survey parties; names verified; the areas of the different soil types measured; drawings prepared for illustrating reports; specifications for lithographic work written; and proof furnished through the Public Printer read.

*Assignment.*—J. W. McKericher.

*Proposed expenditures, 1918-19.*—\$14,700.

**Photographic Reproduction of Base Maps:**

*Object.*—To enlarge or reproduce by photographic process base maps for the use of soil-survey field parties and for the map-drafting force.

*Location.*—Washington, D. C.

*Date begun.*—1898.

*Results.*—County maps of all areas surveyed during the year have been reproduced and mounted, negatives developed, and prints made for use in bureau reports.

*Assignment.*—T. O. Crown.

*Proposed expenditures, 1918-19.*—\$1,700.

**Special Soil Studies:**

*Object.*—To investigate the distribution, relationship, and characteristics of the important soil series and soil types of the country; and to conduct a detailed study of the adaptability of soils to certain crops.

*Location.*—Washington, D. C., and in the field.

*Date begun.*—1911.

*Results.*—Studies have been made of the relation of soils to crops in Virginia, including the preparation of report on the soils of the Norfolk trucking district and their uses. Field studies of the Hagerstown soils between the Delaware and Roanoke Rivers have been continued.

*Assignment.*—J. A. Bonsteel.

*Proposed expenditures, 1918-19.*—\$3,850.

**Advisory Service:**

*Object.*—To answer inquiries regarding soils and give advice as to their use.

*Cooperation.*—Other bureaus of the department.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—It is estimated that replies have been made during the past year to upward of 1,200 inquiries regarding the use of soils.

*Assignment.*—J. E. Lapham.

*Proposed expenditures, 1918-19.*—\$2,500.

**Supplies:**

*Object.*—To purchase instruments and supplies required for use in the soil-survey work.



*Location.*—Washington, D. C.

*Date begun.*—1898.

*Proposed expenditures, 1918-19.*—\$3,500.

**Total, Soil-Survey Investigations, \$223,860, including \$25,660 statutory.**

[Research.]

## CLASSIFICATION OF AGRICULTURAL LANDS IN FOREST RESERVES.

### Forest-Land Classification:

*Object.*—To classify and segregate agricultural lands in the national forests.

*Cooperation.*—Forest Service.

*Location.*—The several forest reserves.

*Date begun.*—1912.

*Results.*—During the past year 83 projects were examined in the following national forests and reports prepared and furnished the Forest Service:

Idaho: Idaho, Minidoka, Salmon, Kàniksu, Nez Perce, Pend Oreille, and Selway.

Montana: Sioux, Deerlodge, Blackfeet, Madison, Lolo, Jefferson, and Bitterroot.

Nevada: Humboldt.

South Dakota: Black Hills.

Utah: La Sal, Fishlake, Filmore, and Powell.

Washington: Olympic.

Wyoming: Shoshone.

*Assignment.*—A. C. Anderson, C. E. Deardorff, J. E. Dunn, H. G. Lewis, A. T. Strahorn.

*Proposed expenditures, 1918-19.*—\$18,100.



## BUREAU OF ENTOMOLOGY.

### GENERAL ADMINISTRATION.

#### Office of Chief:

*Object.*—General administration, supervision, and direction of the investigations and business activities of the bureau.

*Cooperation.*—All the bureaus of the department, other executive departments, and State institutions.

*Location.*—Washington, D. C.

*Date begun.*—1879.

*Assignment.*—L. O. Howard, chief; C. L. Marlatt, assistant chief; E. B. O'Leary, administrative assistant.

*Proposed expenditures, 1918-19.*—\$15,300.

#### Office of Chief Clerk:

*Object.*—The chief clerk is the executive officer of the bureau and has general supervision of the clerical force, the messenger service, the care of offices, and the maintenance of records.

*Location.*—Washington, D. C.

*Date begun.*—1879.

*Assignment.*—A. J. Leister.

*Proposed expenditures, 1918-19.*—\$13,490.

#### Accounts:

*Object.*—Supervision and maintenance of financial records of the bureau.

*Location.*—Washington, D. C.

*Date begun.*—1879.

*Assignment.*—W. E. Wilson.

*Proposed expenditures, 1918-19.*—\$14,000.

#### Library:

*Object.*—To conduct work incidental to the maintenance of a library of entomological literature.

*Location.*—Washington, D. C.

*Date begun.*—1879.

*Assignment.*—Mabel Colcord.

*Proposed expenditures, 1918-19.*—\$2,600.

#### Supplies:

*Object.*—The purchase, custody, distribution, and record of all equipment and materials for field and office use.

*Location.*—Washington, D. C.

*Date begun.*—1879.

*Assignment.*—S. B. Walker.

*Proposed expenditures, 1918-19.*—\$3,340.

#### Editorial Work:

*Object.*—To conduct the editorial work of the bureau and facilitate the publication of the results of entomological investigations.

*Location.*—Washington, D. C.

*Date begun.*—1879.

*Assignment.*—Rolla P. Currie.

*Proposed expenditures, 1918-19.*—\$4,850.

#### Files and Records:

*Object.*—The filing of all correspondence pertaining to the operations of the bureau.

*Location.*—Washington, D. C.

*Date begun.*—1879.

*Assignment.*—T. A. Keleher.

*Proposed expenditures, 1918-19.*—\$1,400.

**Total, General Administration, \$54,980, including \$45,980 statutory (research, \$49,160; regulation, \$5,820).**



[Research.]

**DECIDUOUS-FRUIT INSECT INVESTIGATIONS.****SUPERVISION.****Supervision:**

*Object.*—To plan and direct the activities relating to deciduous-fruit insect investigations, including supervision of scientific work, general office routine, correspondence, etc.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—A. L. Quaintance.

*Proposed expenditures, 1918-19.*—\$7,900, including \$3,000 statutory.

**APPLE INSECT INVESTIGATIONS.****Apple-Tree Borers:**

*Object.*—To determine the life histories and habits of the various species of apple-tree borers and to develop appropriate remedies therefor.

*Procedure.*—Extensive investigations in orchards are made to determine species of troublesome borers and the amount of injury resulting from their work. Insects are collected and reared in the field laboratory and observations made on their life history, habits, etc. Laboratory observations are checked by extended observations in the field. Remedial measures are undertaken based on knowledge of the behavior of the insect. The work will be extended to include all important species of borers, with a view to furnish a comprehensive account of these insects as a class.

*Location.*—French Creek, W. Va.

*Date begun.*—1911.

*Results.*—The biologies of several species of borers have been investigated, and other species are under investigation. Many preparations have been and are being tested as remedies, some of which are effective in preventing infestation by certain species. Information relative to the round-headed apple-tree borer and the so-called shot-hole borers is contained in Farmers' Bulletins 675 and 763, respectively.

During 1918 further progress was made in the study of the shot-hole borer, the flat-headed apple-tree borer, and the grapevine root borer. A publication is now in press on the grapevine root borer and a manuscript nearly completed on the flat-headed apple-tree borer.

*Probable date of completion.*—1920.

*Assignment.*—F. E. Brooks.

*Proposed expenditures, 1918-19.*—\$2,810.

**Apple Plant Lice:**

*Object.*—To determine the life histories of and remedies for apple and other orchard aphids, such as the woolly apple aphid, green apple aphid, rosy apple aphid, etc.

*Procedure.*—Careful biological studies of these insects are made in the laboratory, especially to determine the character of injury, number of generations, host plants, manner of wintering, etc. Remedial investigations are undertaken in the field to determine the most effective sprays and times when applications should be made, as, in winter, for the destruction of eggs, and, in early spring, for the destruction of the newly hatched insects, and to determine the possibilities of control by the use of aphiscides in combination with other sprays. Future work on this project will include a study of other species of orchard aphids.

*Location.*—Washington, D. C., and Winchester, Va.

*Date begun.*—1912.

*Results.*—The biology of the woolly apple aphid has been thoroughly worked out and a publication issued (Report No. 101, Office of the Secretary). Studies of the life history of the green apple aphid have been completed and the results published. The investigation of the rosy apple aphid has also been finished and a report issued in the Journal of Agricultural Research, vol. 7, No. 7.

During 1918 continued attention was given to the study of aphids attacking currants and gooseberries, the black cherry aphid, and the black peach aphid. Studies on the mealy plum aphid have been completed and a manuscript submitted for publication. A publication on



aphids attacking deciduous fruits has been issued as Farmers' Bulletin 804.

*Probable date of completion.*—1920.

*Assignment.*—A. C. Baker.

*Proposed expenditures, 1918-19.*—\$2,450.

### **Codling Moth:**

*Object.*—To determine what variations are necessary in spraying schedules to control the codling moth in widely separated fruit districts, such as Maine, Arkansas, Michigan, New Mexico, California, Oregon, Colorado, the Allegheny region, etc.

*Procedure.*—Field laboratories are established in important apple-growing regions representing essentially different climatic and other conditions. The biology of the codling moth is thoroughly investigated, especially as bearing on the question of its control in orchards. Experiments are carried out in the field to determine the comparative value of the respective spray treatments, the most effective quantity of poison to be employed, and similar questions of practical importance. The work will be extended to one or two additional apple-growing sections in the United States, which will complete the project.

During the study of this insect in the United States for the past several years a large amount of data has been accumulated on the relation of the behavior of the insect under different climatic conditions. A careful study of this data is being made, with a view to determine, if possible, the exact relation of climatic factors to the transformations of the insect and the injuries it causes.

*Cooperation.*—Colorado, Oregon, and New Mexico agricultural experiment stations.

*Location.*—Grand Junction, Colo., Roswell, N. Mex., Medford, Oreg., Winchester, Va., and Washington, D. C.

*Date begun.*—1908.

*Results.*—The work has been completed in Michigan, Pennsylvania, the Allegheny region, California, and Maine. A publication on the life history of the codling moth in the Pecos Valley, N. Mex., has been issued as Department Bulletin 492.

During 1918 additional data were obtained on the biology of the codling moth under arid conditions in the Grand Valley of Colorado and advance made in perfecting a spraying schedule suitable for the conditions in this valley. A manuscript on the biological studies of this insect in Colorado will be finished shortly and submitted for publication. A thorough biological study of the codling moth is under way in the Rogue River Valley, Oreg., as well as experiments in the use of sprays and dusts in its control. The investigations in the Pecos Valley, N. Mex., have been limited largely to work in the field with various sprays and dusts, to determine the number of applications most effective and economical in the control of the pest. It is hoped that the work in the Pecos Valley may be concluded at the close of the present growing season. Work in Virginia has been conducted to determine the comparative merits of dust and liquid sprays, especially on varieties of apples not much subject to fungous diseases. Results obtained during 1918 indicate a distinct field of usefulness for dust sprays on this class of apples.

*Probable date of completion.*—1920.

*Assignment.*—M. A. Yothers, R. J. Fiske, B. R. Leach, L. C. Antles, P. W. Mason.

*Proposed expenditures, 1918-19.*—\$13,400.

**(Relation of Insects to Stigmonose.** Temporarily discontinued as an active project of the Bureau of Entomology; work being prosecuted by the Bureau of Plant Industry in cooperation with this bureau.)

### **Apple-Tree Tent Caterpillar:**

*Object.*—To investigate the biologies, habits, insect parasites, and diseases of the tent caterpillar and determine methods for its control.

*Procedure.*—A field laboratory has been established at Wallingford, Conn. Detailed studies will be made of all phases of the life and habits of the insect and its parasites. Special attention will be given to determine the cause of the wide fluctuations in the abundance of the insect every few years. Large-scale field experiments will be made to test various



methods of destroying the caterpillars, as by spraying, the development and use of special apparatus for poisoning the foliage of high trees, tests of various contact materials in the destruction of the caterpillars in their nests, etc. If feasible, it is planned to secure the cooperation of school children and others in the collection of egg masses.

*Cooperation.*—Connecticut (New Haven) Agricultural Experiment Station.

*Location.*—Wallingford, Conn.

*Date begun.*—1917.

*Results.*—The tent caterpillar has long been known as an apple-tree pest and has received a good deal of attention by entomologists. No thorough-going study of the insect, however, has heretofore been undertaken. During 1918 a large amount of information was obtained relative to the native parasitic and predatory enemies of the tent caterpillar, and numerous species of these are being propagated with a view to their distribution in orchards. Biological studies of the insect are under way, as well as practical experiments in its control.

*Probable date of completion.*—1920.

*Assignment.*—E. H. Siegler, B. A. Porter.

*Proposed expenditures, 1918-19.*—\$5,000.

### **Apple Insect Investigations in the Ozarks:**

*Object.*—To investigate the biologies of various destructive apple and other insects in the Ozarks and develop appropriate remedies for their control.

*Procedure.*—A laboratory has been established at Bentonville, Ark., where the more technical studies will be made. In conjunction with and based on the life-history studies, experiments with insecticides looking to the control of the injurious species will be carried out in the orchards. Observations will be made and experiments conducted with such species as the lesser apple worm, apple-twigg borer, canker worms, scale insects, etc.

*Location.*—Bentonville, Ark.

*Date begun.*—1917.

*Results.*—This is a new project and no results are yet to be reported.

*Probable date of completion.*—1921.

*Assignment.*—A. J. Ackerman

*Proposed expenditures, 1918-19.*—\$2,580.

**Total, Apple Insect Investigations, \$26,240.**

### **PEACH INSECT INVESTIGATIONS.**

#### **Peach Borer and Miscellaneous Peach Insects:**

*Object.*—To determine the life history and habits of the peach borer and other peach insects and to develop appropriate remedies therefor.

*Procedure.*—The biology of the peach borer is investigated in orchards and in the laboratory, and experiments with remedies are conducted on a large scale in orchards. In connection with this work other peach insects, such as the plum curculio, peach-twigg borer, oriental peach moth, etc., are studied and experiments in their control made. The work eventually is to cover all of the more important peach insects of the United States.

*Location.*—Fort Valley, Ga., Portland, Oreg., and Washington, D. C.

*Date begun.*—1911.

*Results.*—The biology, food plants, etc., of the peach borer have been fairly well determined for different parts of the country where peaches are grown. Many washes and practices recommended for its control have been tried, most of which have been found to be without value. Extensive tests with soil fumigants, which at first gave promise of good results, upon further experimentation indicate that some of the fumigants can not be used on account of danger of injury to the trees. At Fort Valley, Ga., experiments are in progress to determine the comparative merits of dust and liquid sprays in the control of peach insects.

During 1918 further information was obtained on the life history of and the injuries caused by the oriental peach moth, recently introduced into this country. Extensive experiments with remedies carried out on the Arlington farm, however, did not show results of importance in its control.

*Assignment.*—J. J. Culver, E. J. Newcomer, W. B. Wood.

*Proposed expenditures, 1918-19.*—\$9,144.



## GRAPE INSECT INVESTIGATIONS.

**Miscellaneous Grape Insects in California:**

*Object.*—To determine the life history of various grape insect pests under California conditions, including investigations of the grapevine mealy bug and the grape leafhopper and a continuation of studies of the grape Phylloxera.

*Procedure.*—The biology of these insects is carefully studied at the laboratory and in the vineyard and extensive tests made with remedies.

*Cooperation.*—Bureau of Plant Industry (varietal resistance to Phylloxera).

*Location.*—Fresno, Cal.

*Date begun.*—1912.

*Results.*—The investigation of the grape Phylloxera is nearly completed, and a manuscript on the biology of the insect has been submitted for publication.

During 1918 continued attention was given to the grapevine mealy bug, which appears to be on the increase. Distinct progress was made in the accumulation of data on its life history and habits, and experiments with remedies indicate a practical control.

*Probable date of completion.*—1920.

*Assigned.*—R. L. Nougaret.

*Proposed expenditures, 1918-19.*—\$2,840.

**Grape Berry Moth and Miscellaneous Grape Insects in the East:**

*Object.*—To determine the life history and habits of the grape berry moth and other important insects affecting the grape and to develop remedies for their control.

*Procedure.*—The biology of the grape berry moth is carefully studied as a basis for the control of this insect in vineyards. Extensive spraying and other experiments are carried out in vineyards to determine the best remedial measures to be employed. In connection with this work other important grape insects are investigated.

*Location.*—Cleveland and Sandusky, Ohio.

*Cooperation.*—Ohio Agricultural Experiment Station.

*Date begun.*—1907.

*Results.*—Many data on the biology of the grape berry moth have been obtained and a publication issued (Entomology Bulletin 116, Part 2, new series). Information about other grape pests has been accumulated and the following publications issued: Entomology Bulletin 89, "The Grape Root Worm"; Department Bulletin 19, "The Grape Leafhopper in the Lake Erie Valley"; Farmers' Bulletin 721, "Rose Chafer"; and a special emergency circular on spraying grapes for the control of insects and diseases.

During 1918 the experiments under way during the previous year were continued, and distinct progress was made in effecting a spraying schedule for the control of the grape berry moth. It had already been determined that two thorough treatments with an arsenical spray and Bordeaux mixture applied just after the falling of the blossoms and two weeks later were effective. Additional attention has been given to determine the compatibility of certain spray mixtures and especially the value of soaps and other materials in increasing the adhesiveness of the sprays. Department Bulletin 550, "Control of the Grape Berry Moth in the Erie-Chautauqua Grape Belt," has been issued.

*Probable date of completion.*—1920.

*Assignment.*—H. G. Ingerson, G. A. Runner.

*Proposed expenditures, 1918-19.*—\$6,240.

**Total, Grape Insect Investigations, \$9,080.**

## NUT INSECT INVESTIGATIONS.

**Pecan Insects:**

*Object.*—To determine the biologies of and remedies for the principal pecan insects.

*Procedure.*—Careful biological studies are made of the more important pecan insects, and experimental control work in pecan groves is carried out.

*Location.*—Monticello, Fla., and Brownwood, Tex.



*Date begun.*—1913.

*Results.*—A large amount of data on important pecan insects has been accumulated.

During 1918 further attention was given to experiments in the control of pecan insects in orchards by the use of arsenical sprays and dusts. It appears probable that one or two of the worst pecan pests can be controlled in a practical way by such measures. During the year two publications were issued, namely, Department Bulletin 571, "The Pecan Leaf Case-Bearer," and Farmers' Bulletin 843, "Important Pecan Insects and Their Control."

*Assignment.*—J. B. Gill, A. I. Fabis.

*Proposed expenditures, 1918-19.*—\$9,600.

**(Chestnut Weevils and Miscellaneous Nut Insects:** This work has been temporarily suspended on account of the resignation of the project leader. Only preliminary experiments have been made. It is possible that the investigations may be continued at some later time.)

#### INVESTIGATIONS OF ORCHARD INSECTICIDES AND SPRAYING MACHINERY.

##### Orchard and Miscellaneous Insecticides:

*Object.*—To determine the comparative value of insecticides in general use and to what extent they may be combined with fungicides of various kinds in the control of insect plant pests; to develop new insecticides and determine their value in insect control and their effect on the insects and plants treated.

*Procedure.*—Numerous insecticides are tested under laboratory and field conditions against different species of insects alone and in combination with fungicides. Experimental work is carried on in combining chemicals to form new insecticides. Before recommendations can be made such insecticides must be fully tested, in order to determine their efficiency against insects and their action on plant life when used alone and when in combination with fungicides.

*Cooperation.*—Bureaus of Plant Industry and Chemistry.

*Location.*—Benton Harbor, Mich., and Washington, D. C.

*Date begun.*—1912.

*Results.*—Orchard tests have been made with many types of commercial insecticides to determine their relative merits. New commercial insecticides are tested as far as practicable, as they appear from year to year, for the information of the department. Feeding experiments have been made with toxic substances to determine their usefulness as insecticides. Studies have been made with the arsenate of lime as a substitute for arsenate of lead and the results published in Department Bulletin 278. Much interest has been evidenced by manufacturers in this arsenical, and it is being offered for sale by several different firms.

During 1918 further progress was made in the investigation of the comparative merits of dust and liquid sprays on various crops, as apple, peach, and grape. It has not been possible to issue a report on this subject, though it is contemplated that a report can be issued at the close of the growing season of 1918. Farmers' Bulletin 908 on the general subject of orchard insecticides has been issued. A specific study has been undertaken of various oils used as insecticides, involving a study of the toxicity of these on insects, their effect on plants, and the best methods of preparation.

*Assignment.*—A. L. Quaintance, F. L. Simanton, J. D. Smith.

*Proposed expenditures, 1918-19.*—\$4,892.

##### Insecticidal Constituents of Plants:

*Object.*—To make a thorough study of known and possible plant constituents having insecticidal value and to determine the physiological action of these substances on insects; to test insecticides thus obtained under field conditions, and to introduce into use such insecticides where feasible.

*Procedure.*—Studies under this project involve work in pharmaceutical botany and pharmaceutical chemistry and the exact determination of the physiological action of the substances obtained with different classes of insects.

*Cooperation.*—Office of Drug-Plant and Poisonous-Plant Investigations, Bureau of Plant Industry.



*Location.*—Washington, D. C.

*Date begun.*—1916.

*Results.*—A thorough study of the action on insects of nicotine has been completed and reported in the *Journal of Agricultural Research*, vol. 7, No. 3.

During 1918 particular attention was given in the laboratory and orchard to determine the value of nicotine as an avicide. The results were not sufficiently conclusive to warrant publication, and the experiments must be continued during the growing season of 1918. Progress has been made in determining the value of various so-called fish poisons and other plant insecticides.

*Assignment.*—N. E. McIndoo, W. A. Hoffman.

*Proposed expenditures, 1918-19.*—\$3,950.

### **Spraying Apparatus and Spraying Efficiency:**

*Object.*—To investigate the relative efficiency of spraying apparatus, noting especially principles of construction, types of gasoline motors, pumps, etc.

*Procedure.*—The relative efficiency of the many types of spraying apparatus now on the market are investigated in orchards and factories. Attention is given to determine the durability of materials used in pumps as affected by spray liquids, methods of packing valves, and other practical points. Estimates are also made of spraying efficiency as practiced by various orchardists, vineyardists, etc., as a basis for suggestions for improvements in such work.

*Cooperation.*—Bureaus of Plant Industry and Public Roads.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—Data have been accumulated on the comparative merits of different types of spray nozzles and spraying accessories, as well as on the comparative value in codling-moth control of sprays applied under low and high pressure.

*Assignment.*—A. L. Quaintance.

*Proposed expenditures, 1918-19.*—\$314.

**Total, Investigations of Orchard Insecticides and Spraying Machinery, \$9,156.**

### **CRANBERRY AND SMALL-FRUIT INSECT INVESTIGATIONS.**

#### **Cranberry and Small-Fruit Insect Investigations:**

*Object.*—To study insects affecting the cranberry and other small fruits, such as the currant, gooseberry, huckleberry, blueberry, etc., and to develop effective control measures.

*Procedure.*—Work at present is confined largely to the cranberry. Careful biological studies are made of the injurious insects of this crop, special attention being paid to their seasonal history in bogs, places of hibernation, etc. Experiments with insecticides are in progress to determine the best remedial measures, and observations on such practices as sanding bogs and reflooding after the bogs have been drained in the spring are being made.

*Location.*—Seaview, Wash.

*Cooperation.*—Washington Agricultural Experiment Station.

*Date begun.*—1913.

*Results.*—A large amount of data has been accumulated on important cranberry insects in New Jersey. Information has been obtained on the effectiveness of flooding bogs and on spraying operations in the control of various cranberry pests. Improvement has been effected in the insecticidal sprays used. A hitherto unrecognized cranberry insect has been discovered and reported upon in Department Bulletin 263, "The Cranberry Rootworm."

During 1918 the work on this project in New Jersey was completed and Farmers' Bulletin 860, "Cranberry-Insect Problems and Suggestions for Solving Them," issued. Several technical publications on cranberry-insect pests have also been issued and others are in course of preparation.

The investigation of cranberry insects in Washington bogs has only recently been undertaken and no results can be indicated.

*Assignment.*—H. K. Plank.

*Proposed expenditures, 1918-19.*—\$2,550.



## CONTROL OF DECIDUOUS-FRUIT INSECTS BY NATURAL AGENCIES.

**Parasitic Hymenoptera:**

*Object.*—To determine the importance of hymenopterous parasites in the control of deciduous-fruit insect pests and devise methods for their practical propagation and dissemination.

*Procedure.*—Parasitized insects are collected from various localities and sent to the laboratory at Wallingford, Conn., for the rearing of parasites. Life histories and habits of parasites are worked out and efforts made to effect their propagation in quantity for dissemination. In connection with investigations of the apple-tree tent caterpillar studies are also being made of the parasites of this insect.

*Location.*—Wallingford, Conn., and East Falls Church, Va.

*Date begun.*—1911.

*Results.*—Biological data have been obtained on several important parasites of deciduous-fruit insects as a basis for their intelligent propagation. Many new parasites have been discovered and their economic status determined. Special attention has been given to parasites of the grape berry moth, and numerous species are being studied in detail. Several papers of a systematic character for the use of student of Hymenoptera have been published.

During the fall of 1917 studies were continued with parasites of the grape berry moth at North East, Pa., and a report upon these insects is in course of preparation.

In the spring of 1918 a part of the work in the study of parasites of the apple-tree tent caterpillar was located at East Falls Church, Va., on account of the great abundance of the insect in that neighborhood.

*Assignment.*—R. A. Cushman.

*Proposed expenditures, 1918-19.*—\$2,600.

**Predatory Insects:**

*Object.*—To determine the importance of predatory insects in the control of deciduous-fruit insect pests and to carry out large-scale experiments in their practical propagation and dissemination.

*Procedure.*—Predatory insects, especially ladybird beetles, Syrphid flies, tiger beetles, etc., are collected and their life histories and habits studied. Where feasible, large quantities of valuable predators are collected in the field and distributed to other parts of the country. In the laboratory valuable species are propagated in quantity for dissemination.

*Cooperation.*—California State Horticultural Commission.

*Location.*—Sacramento, Cal.

*Date begun.*—1916.

*Results.*—Distinct progress has been made in the study of the ladybird beetle, *Hippodamia convergens*. Methods of storage of the beetles before distribution are being investigated. The life histories of several other useful ladybirds have also been given attention.

During 1918 a special study of the *Hippodamia* in the Imperial Valley of California was conducted to ascertain results following their liberation in large quantities in fields. Several interesting facts have been developed from this study and further observations will be made.

*Probable date of completion.*—1920.

*Assignment.*—W. M. Davidson.

*Proposed expenditures, 1918-19.*—\$2,600.

**Fungous Diseases of Insects:**

*Object.*—To investigate the fungi parasitic on deciduous-fruit insects, with a view to their utilization in the control of insect pests.

*Procedure.*—Mycological methods of study are employed in the isolation and growing of the organisms. Pure cultures of various species of fungi are experimented with to determine their period of incubation, method or methods of attacking insects, and the possibility of increasing their virulence. Attention is given to the development of methods whereby fungi can be grown in large quantities, with a view to effect the control of injurious insects in the field.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Washington, D. C.

*Date begun.*—1916.



*Results.*—During 1918 the investigation of the *Sorospora* disease of cutworms was continued and further facts developed regarding the life history of the parasite, methods of propagation, and effectiveness.

*Assignment.*—A. T. Speare.

*Proposed expenditures, 1918-19.*—\$2,550.

**Total, Control of Deciduous-Fruit Insects by Natural Agencies, \$7,750.**

#### DECIDUOUS-FRUIT NURSERY INSECT INVESTIGATIONS.

##### Deciduous-Fruit Nursery Insect Investigations:

*Object.*—To investigate the various insects affecting nursery stock and to develop remedies which may be effectively applied under nursery conditions; to investigate the efficiency of fumigation methods now employed by nurserymen, and to effect improvements in disinfecting nursery stock.

*Procedure.*—Careful studies are made of all important insect enemies of nursery stock and remedies developed which may be applied under nursery conditions. Observations are made on methods of fumigation now practiced by nurserymen, the efficiency of this work, and effect on the plants treated.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—Valuable information has been accumulated on different species of insects which are the most important pests of nursery trees, and the life histories and habits of some of these have been studied. Experiments have been made in the fumigation of nursery stock, and inquiry is under way on fumigation methods practiced by nurserymen and on their fumigatoriums, with the view of ascertaining how effectively the work is being done and of suggesting improvements in methods where necessary.

During 1918 additional work was done on the apple leafhopper and the woolly apple aphid on nursery stock.

*Assignment.*—A. L. Quaintance.

*Proposed expenditures, 1918-19.*—\$300.

#### ORCHARD INSECT SURVEY.

##### Orchard Insect Survey:

*Object.*—To obtain information on the large number of insect pests of orchards, vineyards, etc., at present of lesser importance in the United States, but which may become important at any time.

*Procedure.*—Insect outbreaks of a serious nature are investigated and information obtained on conditions responsible for such outbreaks. Insects are collected in orchards, vineyards, etc., and a good many are obtained through correspondence. Necessary records, photographs, and drawings of insects and of plant specimens showing injury are made, to be used in publications and for reference purposes.

*Location.*—Washington, D. C., and Bentonville, Ark.

*Date begun.*—Work of this character has been in progress for many years.

*Results.*—A large amount of information has been accumulated on miscellaneous insects of orchards, vineyards, etc., in the United States. Specimens of these have been collected for use in making drawings and descriptions. A large collection of notes and photographs is already on file and is being rapidly enlarged.

*Assignment.*—J. H. Paine, Dwight Isely.

*Proposed expenditures, 1918-19.*—\$4,660.

#### INVESTIGATION OF THE IMPORTED JAPANESE BEETLE.

##### Investigation of the Imported Japanese Beetle:

*Object.*—To investigate thoroughly the biology, habits, and destructiveness of the recently introduced Japanese beetle, *Popillia japonica*, which attacks orchard and other fruits, and to effect, if possible, its eradication from the area where it is now established in the vicinity of Riverton, N. J.

*Procedure.*—In cooperation with the New Jersey State Entomologist, a laboratory has been established at Riverton, N. J., where biological



studies and experimental work are in progress. Special attention is being given to the eradication of the pest by keeping thoroughly poisoned all its known food plants, by a systematic and thorough hand picking of the beetles, and by destroying the larvæ of the insect in the soil by the use of soil fumigants and by plowing. Supplementing these operations, adequate quarantine measures are maintained by the State of New Jersey under its crop-pest law and by the Federal Horticultural Board.

*Cooperation.*—New Jersey State Entomologist.

*Location.*—Riverton, N. J.

*Date begun.*—1918.

*Results.*—Important information has already been obtained on the life history of the insect, its food plants, and the injuries which it causes. Experiments have been made with poisons in the destruction of the adult beetles and with fumigants in the destruction of the larvæ in the soil.

*Probable date of completion.*—1920.

*Assignment.*—A. L. Quaintance, William O. Ellis, T. J. Headlee.

*Proposed expenditures, 1918-19.*—\$10,000.

**Total, Deciduous-Fruit Insect Investigations,** \$96,380, including \$3,000 statutory.

(See also Supplement—Emergency Activities, p. 562.)

[Research.]

## CEREAL AND FORAGE INSECT INVESTIGATIONS.

### SUPERVISION.

#### Supervision:

*Object.*—To plan and direct the activities relating to cereal and forage insect investigations, including supervision of scientific work, general office routine, correspondence, etc.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Assignment.*—W. R. Walton.

*Proposed expenditures, 1918-19.*—\$10,240, including \$4,440 statutory.

### CEREAL INSECT INVESTIGATIONS.

#### Hessian Fly:

*Object.*—To study the life history, development, and distribution of the parasites of the Hessian fly, in order that their services may be artificially utilized more intelligently; to determine the most efficient means of eradicating the pest, the varieties of grain least subject to attack, and the effect of various cultural methods, as well as of various fertilizing substances, on the pest.

*Procedure.*—The work consists chiefly of field experiments. Plots of ground located in regions most abundantly infested by the pest are planted to wheat, cultivated in several different ways at different times, and the effect of various fertilizers noted. The most approved meteorological apparatus is used for the purpose of measuring the effect of moisture and temperature on the insect. Apparatus is also installed for the purpose of ascertaining the exact time of emergence of the adults from the ground and their powers of flight.

*Location.*—Eastern and Middle United States and the Pacific-coast region.

*Date begun.*—1905.

*Results.*—Satisfactory progress was made in the investigation of this problem during the past year, and an additional publication dealing with the practical control of the pest was issued. These investigations were enlarged, beginning July 1, 1917, and a most vigorous and intensive investigation of the problem was begun. Every possible effort is being made to discover and apply the most efficient means of destroying the pest. Active cooperation with various State experiment stations has been instituted, and practical results of the campaign are already beginning to appear.

*Probable date of completion.*—1920.

*Assignment.*—J. R. Horton, J. J. Davis, W. R. McConnell, C. N. Ainslie, T. D. Urbahns, A. F. Satterthwait, C. W. Creel.

*Proposed expenditures, 1918-19.*—\$12,160.



**(Dipterous Enemies of Grains Other than the Hessian Fly: Project completed.**

A publication is in course of preparation showing that the principal frit fly affecting wheat which occurs in this country is identical with the injurious frit fly of Europe, and that at times it assumes the same habits as the European frit fly.)

**European Corn Borer:**

*Object.*—To determine the exact area infested by the European corn borer (*Pyrausta nubilalis*) and the most feasible means of controlling it and preventing its spread. This pest is known to injure Indian corn very seriously in Europe. It has already manifested its power of continuing such injuries in Massachusetts. The caterpillars attack not only the corn ears but also the stalks in many places, including the upper portions below the tassel, often causing it to spill the pollen on the ground and thus preventing fertilization of the ears.

*Procedure.*—Investigations will be carried on in eastern Massachusetts in cooperation with the Massachusetts Agricultural Experiment Station, and a temporary field laboratory has been established at Arlington, Mass., with this in view.

*Cooperation.*—Massachusetts Agricultural Experiment Station and State Department of Agriculture.

*Location.*—Hagerstown, Md., and Arlington, Mass.

*Date begun.*—1918.

*Results.*—The farmers and others in infested sections have been advised, through the field forces of the States Relations Service and State agricultural organizations, to destroy last year's cornstalks and weeds.

*Probable date of completion.*—1923.

*Assignment.*—D. J. Caffrey.

*Probable expenditure, 1918-19.*—\$4,500.

**Cutworms:**

*Object.*—To investigate the life history and habits of all species of cutworms in the United States affecting cereal and forage crops, together with their parasites and other natural enemies.

*Procedure.*—The diverse habits of the various species of cutworms make it necessary that each species be studied separately over its entire area of distribution, and this is accomplished by means of extensive field studies and laboratory investigations.

*Location.*—Temporary and other field stations throughout the United States.

*Date begun.*—1912.

*Results.*—A Farmers' Bulletin describing methods of eliminating the ordinary cutworms which infest the eastern portion of the country has been published. Progress has been made in the investigations of the western army cutworm, and the knowledge of its habits and methods of controlling it has been increased. The fact that species of cutworms hitherto not known to be especially injurious are constantly appearing requires a readjustment of methods of treatment and makes it necessary to continue and extend these investigations.

*Assignment.*—J. J. Davis, C. N. Ainslie, A. F. Satterthwait, J. R. Horton, R. A. Vickery, G. G. Ainslie.

*Proposed expenditures, 1918-19.*—\$3,000.

**Corn-Leaf Aphis:**

*Object.*—To determine the relation of the corn-leaf aphis (*Aphis maidis*) to other similar species; to investigate methods of control, especially along the southern border of the country, where, instead of attacking corn, as in the North, it attacks and destroys young growing barley, in some localities preventing the cultivation of that crop; it is also a serious pest on sorghum in the Gulf States.

*Procedure.*—This project is conducted by means of laboratory experiments, field work in small laboratory plats, and field experimentation on selected farms.

*Location.*—West Lafayette, Ind., San Antonio, Tex., Knoxville, Tenn., and Tempe, Ariz.

*Date begun.*—1911.



*Results.*—Satisfactory progress has been made in these investigations, but further work will be necessary in the development of effective methods of eradication.

*Probable date of completion.*—1919.

*Assignment.*—R. A. Vickery, G. G. Ainslie, V. L. Wildermuth.

*Proposed expenditures, 1918-19.*—\$3,000.

### **Chinch Bug:**

*Object.*—To investigate all possible means of controlling this pest, including the efficacy of burning during the winter and the utilization of various traps and sprays for the purpose of destroying the bugs.

*Procedure.*—Careful experiments are conducted to determine the best methods of trapping the bugs in their annual migration from wheat to corn and of destroying them in their winter quarters. Spraying apparatus of the latest and most approved design is used in applying various insecticidal substances in order to determine the best possible spray to be used in the eradication of the pest.

*Location.*—Wellington, Kans., Lafayette, Ind., and Charleston, Mo.

*Date begun.*—1911.

*Results.*—Excellent progress has been made in the spraying experiments. It has been determined that fumigation of corn shocks with poisoned gases is effective under certain conditions. These investigations are being continued. A poster describing and illustrating the annual activities of the bug, together with the proper apparatus for its extermination, has been published in an edition of 30,000 copies and distributed widely throughout the region most generally infested by the pest.

*Probable date of completion.*—1920.

*Assignment.*—J. R. Horton, J. J. Davis, A. F. Satterthwait, P. Luginbill.

*Proposed expenditures, 1918-19.*—\$6,160.

### **Western Corn Rootworm:**

*Object.*—To find some practical means of preventing injuries by the corn rootworm in sections subject to the annual overflow of streams.

*Procedure.*—Both laboratory and field experiments are conducted, the latter being in many instances in cooperation with farmers.

*Location.*—Knoxville, Tenn., Lafayette, Ind., and Charleston, Mo.

*Date begun.*—1912.

*Results.*—The insect during the past year has done great injury in the corn belt by devouring the silks and thus preventing proper pollination of the ears. Preliminary results were published in Department Bulletin 8.

*Probable date of completion.*—1919.

*Assignment.*—J. J. Davis, G. G. Ainslie, A. F. Satterthwait.

*Proposed expenditures, 1918-19.*—\$2,325.

### **Southern Corn Rootworm:**

*Object.*—To devise means for protecting the corn crop of the Southern States from the ravages of the rootworm.

*Procedure.*—A careful study of the life history of this species is being made by laboratory experimentation, and field experiments are being carried out on a large scale.

*Cooperation.*—University of South Carolina and University of Florida.

*Location.*—Knoxville, Tenn., Charleston, Mo., and Columbia, S. C.

*Date begun.*—1913.

*Results.*—Because of the growing importance of the southern corn rootworm these activities have been enlarged and intensified. Experimental plats have been planted in North Carolina, South Carolina, Georgia, and northern Florida, with a view to ascertain whether corn planted at any particular time is immune or less liable to the attacks of this pest. A Farmers' Bulletin giving partial results of the investigations has been published.

*Probable date of completion.*—1920.

*Assignment.*—Philip Luginbill, W. J. Phillips, A. F. Satterthwait, G. G. Ainslie.

*Proposed expenditures, 1918-19.*—\$8,100.

**(Colorado Corn Rootworm:** Project suspended. It has been determined that this insect is of comparatively little importance at the present time.)



**Wireworms:**

*Object.*—To determine the different species of wireworms attacking grain and forage crops, their habits and life histories, the most favorable conditions for their development, and methods of control.

*Procedure.*—Each species is carefully studied under laboratory conditions and these results checked by field experiments conducted under conditions comparable with those encountered by the farmer in combating the pest.

*Location.*—Hagerstown, Md., Charleston, Mo., Carlisle, Pa., and Wellington, Kans.

*Date begun.*—1911.

*Results.*—Many new facts have been learned regarding the effect of the artificial drainage of land upon certain species of wireworms inhabiting wet soils. Numerous insecticidal compounds, both proprietary and standard, have been experimented with in order to find a substance which will destroy wireworms when applied to the soil. As yet no thoroughly effective substance has been discovered, although some of the articles seem more or less promising. A summary of the latest methods of destroying wireworms has been published in Farmers' Bulletin 835. Because of the extreme importance of this problem the activities have been enlarged and intensified.

*Probable date of completion.*—1920.

*Assignment.*—D. J. Caffrey, A. F. Satterthwait, W. R. McConnell, J. R. Horton.

*Proposed expenditures, 1918-19.*—\$8,645.

(*Diabrotica Balteata*: Project completed. A bulletin embodying the results of this investigation will be prepared for publication.)

**Native Species of White Grub:**

*Object.*—To destroy or prevent the appearance of white-grub (*Lachnosterma*) larvæ in fields, determine the identity of parasites and the extent to which such natural enemies may be artificially utilized, study the life cycle of the various species, and discover whether or not this pest can be successfully combated by definite systems of crop rotation designed to hold it in check.

*Procedure.*—The leader of this project visits various sections of the country where the larvæ or grubs occur in destructive abundance, studying the nature of the soil, the topography of the country, and the nature of the forest flora which is most likely to produce food for the adult beetle. Collections are made at the time of plowing the infested fields, and this information is studied with relation to previous systems of crop rotation.

*Cooperation.*—State entomologists of Illinois, Alabama, and Texas and the government entomologists of the Dominion of Canada.

*Location.*—La Fayette, Ind., Charlottesville, Va., Hagerstown, Md., Wellington, Kans., and Carlisle, Pa.

*Date begun.*—1911.

*Results.*—During the past year a great amount of new information was secured and is being prepared for publication in a comprehensive bulletin entitled "Parasitic Enemies of White Grubs"; Farmers' Bulletin 940, "Common White Grub," was issued; and an illustrated poster summarizing the most recent information regarding the means of destroying white grubs was prepared and distributed throughout the entire section most extensively infested by these insects.

*Probable date of completion.*—1920.

*Assignment.*—J. J. Davis, W. J. Phillips, D. J. Caffrey, J. R. Horton, W. R. McConnell.

*Proposed expenditures, 1918-19.*—\$11,700.

**Jointworms:**

*Object.*—To establish the identity of each of the grain or grass infesting species of jointworms and their relationship to one another, determine the area of distribution of the at present supposed species, and investigate methods of control, including studies of natural enemies.

*Procedure.*—The various species are artificially reared in laboratory experiments from their native wild grasses, and field tests are then made to see whether the pest will forsake its natural food plant to attack cultivated grains and grasses.



*Location.*—Charlottesville, Va., La Fayette, Ind., Wellington, Kans., Charleston, Mo., and Carlisle, Pa.

*Date begun.*—1911.

*Results.*—Methods of control for jointworms have been completed, and Farmers' Bulletin 1006 dealing with the subject has been published.

*Probable date of completion.*—1919.

*Assignment.*—W. J. Phillips, J. J. Davis, A. F. Satterthwait, W. R. McConnell.

*Proposed expenditures, 1918-19.*—\$3,600.

#### **Sod Webworms:**

*Object.*—To study the life history, habits, and natural enemies of these moths and their larvæ in connection with the cultivation of cereals throughout the United States.

*Procedure.*—The life history and habits of this species are being minutely studied by means of cage experiments in the laboratory and out of doors. These studies are supplemented by experiments conducted under field conditions.

*Location.*—Nashville, Tenn., Charlottesville, Va., Hagerstown, Md., and Columbia, S. C.

*Date begun.*—1913.

*Results.*—A publication dealing with one of the most important of the webworms is in preparation. The investigations will be continued in order to perfect the methods of control.

*Probable date of completion.*—1920.

*Assignment.*—G. G. Ainslie, W. J. Phillips, D. J. Caffrey, Philip Luginbill.

*Proposed expenditures, 1918-19.*—\$4,300.

**(Fall Army Worm:** Project completed. A publication reporting fully on the investigations is in course of preparation.)

#### **False Wireworms:**

*Object.*—To study the life history and habits of false wireworms affecting growing grain and to devise methods for their control.

*Procedure.*—Similar to that adopted in investigating wireworms.

*Location.*—Wellington, Kans., and Tempe, Ariz.

*Date begun.*—1911.

*Results.*—Many important facts relating to the life history and habits of these insects have been discovered, but no satisfactory means of controlling them has yet been devised.

*Probable date of completion.*—1920.

*Assignment.*—J. R. Horton, V. L. Wildermuth, J. S. Wade.

*Proposed expenditures, 1918-19.*—\$1,000.

#### **Corn Earworm:**

*Object.*—To investigate the life history and habits of the corn earworm with a view to develop effective control measures. This insect causes very serious and general losses to field corn throughout the southeastern portion of the country, but the fact that it is able to subsist upon many plants, both wild and cultivated, has made its control a difficult problem.

*Procedure.*—The life history and habits of the species in its relation to field corn will be studied minutely in the field and laboratory, and experiments will be conducted to determine the efficacy of various cultural methods and of the use of insecticides in combating this pest.

*Location.*—San Antonio, Tex., Columbia, S. C., Knoxville, Tenn., Charlottesville, Va., and Carlisle, Pa.

*Date begun.*—1917.

*Probable date of completion.*—1922.

*Assignment.*—R. A. Vickery, Philip Luginbill, G. G. Ainslie, W. J. Phillips, W. R. McConnell.

*Proposed expenditures, 1918-19.*—\$2,100.

#### **Miscellaneous Cereal Insects:**

*Object.*—To investigate sporadic or periodic outbreaks of insects that may attack cereal crops in the field and any other cereal-infesting insects whose sudden appearance in unusual numbers may require immediate attention; also to investigate such other cereal insects as may not heretofore have been known as destructive.

*Date begun.*—1910.



*Results.*—A publication treating fully of the lesser cornstalk borer, and giving reliable methods of control has been issued. The following publications have been issued: Farmers' Bulletin 835, treating generally of insects affecting cereal crops; a Farmers' Bulletin on the rough-headed cornstalk beetle, giving methods of control; Department Bulletin 432, dealing with the spike-horned leaf-miner, an enemy of grains and grasses; and Farmers' Bulletin 747, summarizing the most recent knowledge regarding the destruction of grasshoppers.

*Assignment.*—All members of the staff.

*Proposed expenditures, 1918-19.*—\$2,540.

**Total, Cereal Insect Investigations, \$73,130, including \$2,680 statutory.**

#### FORAGE INSECT INVESTIGATIONS.

##### **Alfalfa-Seed Chalcis:**

*Object.*—To study the life history of the chalcis and determine some practical method of preventing the large percentage of loss of clover and alfalfa seed due to this insect; to conduct life-history studies of native parasites of the alfalfa and clover seed chalcis, with the view of controlling the pest.

*Procedure.*—Laboratory investigations of the insect and its parasites are conducted, supplemented by actual field experimentation in control measures.

*Cooperation.*—State entomologist and commissioner of agriculture of Arizona.

*Location.*—Berkeley, Cal., Tempe, Ariz., and Forest Grove, Oreg.

*Date begun.*—1912.

*Results.*—Publications giving results of the investigation of several parasites of the chalcis have been published during the year. Progress has been made in developing proper control measures. These consist of cultural methods easily applied by alfalfa growers. A 20-acre plat of alfalfa land has been furnished the department by the farmers of the Buckeye Valley, Ariz., for the purpose of conducting control experiments. The investigations will be continued with a view to perfect the control measures. A publication reporting on the progress of the California investigation is in preparation.

*Probable date of completion.*—1920.

*Assignment.*—T. D. Urbahns, V. L. Wildermuth, C. W. Creel.

*Proposed expenditures, 1918-19.*—\$12,600.

##### **Insects Affecting the Production of Clover Seed:**

*Object.*—To carry on life-history studies of the clover-seed chalcis, which affects both clover and alfalfa, and investigate various other insects affecting clover seed, including a study of insect fertilization of the bloom.

*Procedure.*—Mode of procedure similar to that followed in investigating the alfalfa-seed chalcis.

*Location.*—Forest Grove, Oreg., Hagerstown, Md., and Charlottesville, Va.

*Date begun.*—1911.

*Results.*—Considerable progress has been made in the investigations of the clover-flower midge and a publication dealing with the control of the insect published and distributed in an edition of 30,000 copies. The investigations of the clover-root borer are also progressing favorably. Control methods are being perfected for the clover-seed chalcis.

*Probable date of completion.*—1920.

*Assignment.*—C. W. Creel, D. J. Caffrey, W. J. Phillips.

*Proposed expenditures, 1918-19.*—\$9,730.

##### **Insects Affecting Soy Beans:**

*Object.*—To study the life history and habits of insects affecting this crop, which is constantly increasing in importance.

*Procedure.*—This project is conducted by means of laboratory and out-of-door breeding experiments, the results of such experiments being then checked up by careful field application.

*Location.*—Charlottesville, Va., Columbia, S. C., Knoxville, Tenn., and Charleston, Mo.

*Date begun.*—1912.



*Results.*—The work on several insect pests of soy beans has been completed, and publications reporting on the investigations are being prepared. These studies will be continued.

*Probable date of completion.*—1919.

*Assignment.*—W. J. Phillips, Philip Luginbill, G. G. Ainslie, A. F. Satterthwait.

*Proposed expenditures, 1918-19.*—\$3,100.

### Range Caterpillar:

*Object.*—To determine methods of eradicating the insect during its different stages of development and to experiment with parasites and other predacious insects and with mechanical devices for the control of this pest.

*Procedure.*—Life-history studies of the insect are made by means of cage experiments and field observations. Observations and experiments with native and imported parasites of this pest are carried on in cages and in the field, and various mechanical devices are tested.

*Location.*—Tempe, Ariz.

*Date begun.*—1913.

*Results.*—The range caterpillar has greatly diminished in numbers during the past year. Great numbers of parasitic enemies have been introduced into New Mexico, and some of these have become established. It will be necessary to keep the insect under surveillance for at least another year, although little injury has occurred for nearly two years.

*Probable date of completion.*—1919.

*Assignment.*—V. L. Wildermuth.

*Proposed expenditures, 1918-19.*—\$1,000.

### Alfalfa Weevil:

*Object.*—To colonize and study the life history and habits of insect and fungous enemies of the alfalfa weevil; to determine the efficiency of cultivation and irrigation, either combined or independently, as a practical means of weevil control; to ascertain the extent of increase in territory covered by the weevil during recent years.

*Procedure.*—Experiments are carried on at field stations of the bureau.

*Cooperation.*—State entomologists of Utah and Colorado.

*Location.*—Salt Lake City, Utah.

*Date begun.*—1910.

*Results.*—Although the alfalfa weevil has spread slowly, it has now entered the Pacific slope of the Rocky Mountains and has been reported from Colorado. Cultural methods of control worked out by the Bureau of Entomology have been widely adopted by alfalfa growers, and the prospect for a full crop in most of the infested region is better at present than for many years past. One of the parasitic insect enemies of the weevil introduced from Europe has been firmly established and has spread to points 30 miles distant from its original point of introduction. Farmers' Bulletin 741, giving the most recent information regarding the control of the insect, has been published.

*Assignment.*—George I. Reeves.

*Proposed expenditures, 1918-19.*—\$12,620.

### Insects Affecting Cowpeas:

*Object.*—To collect information relative to all insects attacking cowpeas, either above or below ground; to determine the influence on the fertilizing value of the plants of the attack of larvæ on the nitrogenous nodules of the roots.

*Procedure.*—Methods of investigation similar to those adopted for the investigation of soy-bean insects are followed.

*Location.*—Charlottesville, Va., Columbia, S. C., Charleston, Mo., and Knoxville, Tenn.

*Date begun.*—1912.

*Results.*—Investigations of *Cerotoma trifurcata*, a small beetle attacking both the leaves and nitrogenous nodules of cowpeas, have been completed, and a publication reporting on the results of the work is being prepared. Progress has been made in the investigation of several other insects affecting this crop, and these studies will be continued.

*Probable date of completion.*—1919.



*Assignment.*—W. J. Phillips, Philip Luginbill, A. F. Satterthwait, G. G. Ainslie.

*Proposed expenditures, 1918-19.*—\$4,100.

### Miscellaneous Forage Insects:

*Object.*—To investigate outbreaks of miscellaneous insects, as occasion may require, when attacking any crop utilized as forage.

*Procedure.*—Investigations of the life histories and habits of the insects are made under both field and laboratory conditions for the purpose of discovering the best methods of devising measures for their control. In the grasshopper work studies are made largely for the purpose of determining the efficacy of arsenicals to be substituted for Paris green, the price of which has risen enormously, and also to reduce the cost of various poison baits.

*Location.*—Throughout the United States.

*Date begun.*—1910.

*Results.*—A publication giving the results of the investigations on the green clover worm is ready for publication. A Farmers' Bulletin containing information relative to the eradication of leafhoppers attacking forage crops has been published. A publication giving the results of investigations of the garden webworm, *Loxostege similalis*, in relation to alfalfa is in press. Progress has also been made in the investigation of other important pests of these crops.

*Assignment.*—All members of the staff.

*Proposed expenditures, 1918-19.*—\$4,360.

**Total, Forage Insect Investigations, \$47,510, including \$1,700 statutory.**

**Total, Cereal and Forage Insect Investigations, \$122,060, including \$8,820 statutory.**

(See also Supplement—Emergency Activities, p. 561.)

[Research.]

## SOUTHERN FIELD-CROP INSECT INVESTIGATIONS.

### SUPERVISION.

#### Supervision:

*Object.*—To direct and supervise the expenditures of the appropriations for southern field-crop insect investigations.

*Location.*—Washington, D. C.

*Date begun.*—1909.

*Assignment.*—W. D. Hunter, W. D. Pierce.

*Proposed expenditures, 1918-19.*—\$8,600, including \$3,500 statutory.

### COTTON INSECT INVESTIGATIONS.

#### Cotton Boll Weevil:

##### (a) CONTROL IN SEVERELY INJURED SECTIONS—

*Object.*—To relieve the present situation in the Mississippi Valley, where cultural methods of controlling the boll weevil have been of comparatively little value, and also furnish relief in other sections where the damage is very severe.

*Procedure.*—This problem will be approached by experiments in the methods of culture and cultivation with regard to the relation of spacing to weevil injury; the use of poisons, especially lead arsenate; the development of suitable machinery for the application of powdered arsenate of lead; the collection of infested squares and fruit and adult weevils; hibernation studies; field studies to correlate conditions affecting weevil injury, in order to determine the relative influence of different factors; intensive study of characteristics of the different cotton varieties with regard to susceptibility to weevil attack; the relation of time of application of fertilizers to weevil injury; and all other means of promise, until the proper means of control in these sections can be perfected.

*Cooperation.*—Arrangements have been made with the States Relations Service whereby one agent will be ready to investigate any section when requested and advise as to control measures. Cooperation is maintained with the State experiment stations in Louisiana and Mississippi.



Arrangements have been made with the Bureau of Public Roads whereby an agent from that bureau will work on the development of power machinery for applying powdered arsenate of lead.

*Location.*—Tallulah, La., and Madison, Fla.

*Date begun.*—1895 in Texas, 1904 in Louisiana, 1910 in Mississippi, 1916 in Georgia, and 1917 in Florida.

*Results.*—In western Louisiana the control of the boll weevil has brought acreage yields back to almost normal. In the Mississippi delta the work of the last five years has given increased confidence to the planters. Definite results have been obtained from the use of powdered arsenate of lead, and the investigation is now continuing to find the cheapest and best means of applying the poison. Careful studies of the farm practices on successful plantations are gradually revealing many points of practical importance.

*Assignment.*—B. R. Coad, R. W. Moreland, E. S. Tucker, T. F. McGehee, G. L. Garrison, F. F. Bondy, W. B. Williams, T. P. Cassidy.

*Proposed expenditures, 1918-19.*—\$28,920.

(b) LIFE-HISTORY STUDIES—

*Object.*—To determine the extent to which the weevil has changed its habits during the period it has existed in the country, and to compare its habits in the newly infested sections with sections infested for a number of years; to study the relation of the condition of weevils entering hibernation in the fall to their vitality and activity in the spring; to ascertain the effect upon the boll weevil of poisons and the manner of ingestion of the same; to determine the relative attractiveness of various chemicals, with the view of finding one which can be poisoned and used as a trap; and to work out the life history of the boll weevil in Sea Island cotton and its relations to Sea Island cotton industries.

*Procedure.*—In Louisiana the life-history, hibernation, and chemical studies are very carefully conducted under all possible conditions. These experiments continue a series started at the Tallulah laboratory. At Victoria and Uvalde, Tex., important biological studies are conducted to compare with the former records. At Madison, Fla., studies are made of the weevil in newly infested areas, especially with regard to its behavior on Sea Island cotton.

*Location.*—Tallulah, La., Victoria and Uvalde, Tex., Madison, Fla., and Washington, D. C.

*Date begun.*—1904.

*Results.*—One of the most important results of the biological studies has been the proof that boll weevils fertilized in the fall are capable of reproduction without further fertilization in the spring. Further results have been obtained in determining the ability of the weevil to live on foods other than cotton and to withstand great severities of climate.

*Probable date of completion.*—In view of the fact that the boll weevil has proven itself an adaptable and changing species, it will probably be necessary to continue the biological studies for several years.

*Assignment.*—B. R. Coad, G. D. Smith, J. A. Nelson.

*Proposed expenditures, 1918-19.*—\$7,500.

(c) STATUS AND DISTRIBUTION—

*Object.*—To determine prospects for damage early in the season, investigate newly infested sections, and study the effect of environment on possible control; to study the distribution of controlling agencies and the extent of spread and actual losses during the season; to map the area of infestation and distribute warnings of future damage.

*Procedure.*—This project is conducted by inspection trips made throughout the year to all infested sections. The dispersion of the weevil is ascertained during the months of September to December by a thorough investigation of the entire outside limits of the weevil infestation.

*Cooperation.*—State entomologists of Georgia, Alabama, Florida, Mississippi, Tennessee, Arkansas, Oklahoma, Louisiana, Texas, and Arizona and demonstration agents of the States Relations Service.

*Location.*—All sections of the cotton belt where the weevil occurs or is reported to occur.

*Date begun.*—1892.

*Results.*—The work under this project is conducted from year to year to meet the demand from planters and others for exact information about



the status of the weevil. By means of the information obtained through this service quarantines against artificial distribution have been inaugurated which have prevented natural spread in several cases, and sporadic occurrences outside of the main infested area have been stopped. The statements issued have been instrumental in determining the course of action of many planters and business men. The usual map showing the spread of the insect was issued.

*Assignment.*—W. D. Pierce.

*Proposed expenditures, 1918-19.*—\$3,000.

### **Cotton Root Aphids:**

*Object.*—To determine means of control.

*Procedure.*—A thorough study is being made of the life history, food plants, and control of the species attacking the roots of cotton.

*Cooperation.*—South Carolina Agricultural College.

*Location.*—Clemson College and Columbia, S. C.

*Date begun.*—1910.

*Results.*—Preliminary results have been published through the South Carolina Experiment Station. These results indicate relief through a rotation of crops.

*Assignment.*—A. F. Conradi, J. A. Berly.

*Proposed expenditures, 1918-19.*—\$500.

**(Cotton Red Spider:** Discontinued as a separate project; further work to be carried on under "Miscellaneous Insects Affecting Cotton." Results published in Farmers' Bulletin 831, "The Red Spider on Cotton and How to Control It," and Department Bulletin 416, "The Red Spider on Cotton.")

### **Cotton Insect Injury in the Imperial Valley, Cal.:**

*Object.*—To determine the extent of injury by the cotton thrips, the cotton leaf-miner, the tarnished plant-bugs, and other insects affecting cotton in the Imperial Valley, and to perfect methods of control.

*Procedure.*—An agent will be stationed at some point in the Imperial Valley to make thorough studies of all cotton pests.

*Cooperation.*—In this work close touch will be maintained with the agents of the Bureau of Plant Industry and the horticultural commissioners in Imperial County, Cal.

*Location.*—El Centro, Cal., and other points in the Imperial Valley.

*Date begun.*—1913.

*Results.*—An extensive list of the insects attacking cotton in the Imperial Valley has been prepared, and a man has been stationed at El Centro for continuous work since 1916. Considerable injury by the tarnished plant-bug and other Hemiptera has been noted, and preliminary studies have been conducted on these species. A survey of the nearby sections of Mexico demonstrated the presence of the cotton boll weevil on a new food plant. Several species previously unknown as enemies of the cotton plant and which are of some local importance were also found. Special means of control will need to be devised.

*Assignment.*—E. A. McGregor.

*Proposed expenditures, 1918-19.*—\$3,500.

### **Miscellaneous Insects Affecting Cotton:**

*Object.*—To determine the extent of the well-known shedding of cotton fruit, which may be due to insects that feed upon the blooms; to study the relation of cutworms, aphids, and other insects to the abortive condition of the plants; to determine means of reducing the damage to the squares by cotton fleas and other piercing bugs; to ascertain the relationship between insects and cotton diseases.

*Procedure.*—A very thorough investigation of the life history of all insects attacking cotton is being made at Madison, Fla. The majority of these insects have not been studied critically, and therefore there are no present known means of control. An effort will be made to find the proper and most expedient means of control for each species. Special attention will be given to the insects known as sharpshooters, cotton stainers, and boll-feeding bugs. The parasites of these insects will be studied carefully.

*Cooperation.*—Cooperation has been secured with all State entomologists in the cotton belt with the view of observing the destruction and spread of cotton insects. Through this cooperation the bureau is able to warn the



entomologists sometimes months in advance of the time of the spread of serious cotton pests.

*Location.*—Madison, Fla., Victoria, Tex., Calxico and El Centro, Cal., Tucson and Phoenix, Ariz., and Tallulah, La.

*Date begun.*—1913.

*Results.*—The principal results obtained under this project have been along the lines of reducing the damage from the cotton-leaf worm and southern grass worm by timely warnings of their approach. A bulletin detailing the life and seasonal history of the cotton Hemiptera of the South-eastern States has been submitted for publication. A large mass of notes has been gathered on the life histories of many cotton pests, and a complete bibliography of the cotton insects of the world has been prepared to assist in this work. Special experiments have been performed to show the importance of various species in the transmission of fungous and bacterial diseases of the cotton plant. These experiments have proved that many cotton insects carry cotton anthracnose on their bodies and give rise to new infestations by walking over uninjured plants.

*Assignment.*—G. D. Smith, W. D. Pierce, J. D. Mitchell, B. R. Coad, E. A. McGregor.

*Proposed expenditures, 1918-19.*—\$6,000.

**Total, Cotton Insect Investigations, \$49,420, including \$1,620 statutory.**

#### TOBACCO INSECT INVESTIGATIONS.

##### **Tobacco Hornworms:**

*Object.*—To test control measures to reduce losses, especially by the use of powdered arsenate of lead and by improvement of dusting machinery, and thus to cheapen further the methods already recommended. Other insecticides will also be tested to determine their efficiency in comparison with arsenate of lead.

*Procedure.*—A sufficiently large force of temporary men are employed to carry out experiments on a number of plantations in Kentucky, Tennessee, North Carolina, Virginia, and Florida. The object of these experiments is to determine the exact dosages and methods of applying the poison under the different conditions obtaining in these widely separated districts.

*Cooperation.*—Tennessee Experiment Station, and growers in Kentucky, Tennessee, North Carolina, Virginia, and Florida.

*Location.*—Clarksville, Tenn., Quincy, Fla., South Boston, Va., and points in Kentucky, Tennessee, North Carolina, and Virginia.

*Date begun.*—1912.

*Results.*—Improvements in the methods of poisoning have been worked out and the practical value of arsenate of lead in the powdered form has been demonstrated to many planters.

*Assignment.*—A. C. Morgan.

*Proposed expenditures, 1918-19.*—\$16,240.

##### **Tobacco Beetle:**

*Object.*—To determine feasible means of preventing losses in warehouses and factories and to the trade.

*Procedure.*—Experiments are conducted to test the value of artificial heat and cold, electrical processes, ultra-violet rays, methods of storage, cleanliness in warehouses and factories, fumigants, and carbon bisulphide and hydrocyanic-acid gas under pressure and vacuum, with a view to find the best means of control for the widely different demands of the industry.

*Cooperation.*—Tobacco dealers, warehouses and factories, manufacturers of different types of electrical apparatus, and the Federal Horticultural Board.

*Location.*—Clarksville, Tenn., Tampa, Fla., Washington, D. C., and other points.

*Date begun.*—1910.

*Results.*—A complete report of the investigations up to 1917 has been submitted for publication. This bulletin contains information as to methods of treating the various classes of stored tobacco for the control of the beetle. It details experiments with heat, cold, Roentgen rays, and fumi-



gation, and gives practical advice as to the manner of using these various methods.

*Assignment.*—Max Kisliuk, jr.

*Proposed expenditures, 1918-19.*—\$2,500.

### **Insect Transmission of Mosaic Disease:**

*Object.*—To determine what insects are capable of transmitting the mosaic disease under different conditions, and to devise means of controlling these insects and of preventing the spread of the disease through them.

*Procedure.*—(1) An intensive study, particularly as to habits, is being made of the insect fauna in and around tobacco fields that show widely different percentages of infestation by the mosaic disease, so as to determine the insects most likely to be concerned in the spread of the disease. (2) The transmission of the disease by insects is studied under artificial conditions in a specially constructed greenhouse during all seasons of the year, with a view to determine what insects are capable of transmitting the disease and also whether insects are capable of carrying the disease over winter.

*Cooperation.*—Bureau of Plant Industry and Tennessee Experiment Station.

*Location.*—Clarksville, Tenn.

*Date begun.*—1913.

*Results.*—Considerable data have been accumulated on many species of insects with regard to their possible effect on the dissemination of this disease. It has been determined that some of these insects may, under certain conditions, transmit the disease.

*Assignment.*—Henry Fox, A. C. Morgan.

*Proposed expenditures, 1918-19.*—\$2,700.

### **Tobacco Budworms and Thrips:**

*Object.*—To perfect methods of controlling these insects, with a view to reduce losses occasioned by them to shade-grown and sun-grown tobacco in Florida and Georgia and sun-grown tobacco in North Carolina, South Carolina, Tennessee, and Kentucky.

*Procedure.*—Careful biological investigations of these insects are made, including studies of their habits and seasonal histories, and a large number of insecticides are tested. An effort is being made further to cheapen the cost of the insecticides used in fighting these pests.

*Cooperation.*—Growers in Florida, Georgia, North Carolina, South Carolina, Kentucky, and Tennessee, and the Tennessee Experiment Station.

*Date begun.*—1910.

*Results.*—In the study of the budworm, insecticides more economical than Paris green have been developed and their value demonstrated.

*Assignment.*—A. C. Morgan, J. U. Gilmore, F. S. Chamberlin.

*Proposed expenditures, 1918-19.*—\$4,000.

### **Miscellaneous Tobacco Insects:**

*Object.*—To determine the possibility of preventing serious losses from miscellaneous insects affecting field-growing tobacco crops, including wireworms, cutworms, flea beetles, and grasshoppers, and further to cheapen the cost of fighting these pests; and to investigate methods of controlling miscellaneous insects which cause serious losses to the stored product, including the large tobacco beetle, the drug-store beetle, and *Silvanus* sp.

*Procedure.*—Careful biological studies are made of tobacco insects which are observed. Methods of control are tested and observations made upon the effect of general farm practices on injury. The efficiency of trap lights and attractive baits will be determined. In the study of stored-tobacco insects careful biological studies are made of all the insects observed and old and new fumigants for their control tested. The effect of ultraviolet rays is also tested.

*Cooperation.*—Tennessee Experiment Station, and tobacco growers, manufacturers, and dealers in Kentucky, Tennessee, North Carolina, South Carolina, Virginia, Georgia, and Florida.

*Location.*—Clarksville, Tenn., Quincy, Fla., South Boston, Va., and points in Kentucky, Tennessee, North Carolina, South Carolina, Virginia, Georgia, and Florida.

*Date begun.*—1910.



*Results.*—A new poison, used in trap baits, for cutworms, wireworms, Crambids, and grasshoppers has been tested, with very promising results. Tests have been made of many cutworm-bait formulæ, and a report on the respective merits of these poisons will be printed in an entomological journal. Many valuable data upon the efficiency of certain sources of light in trap lights have been secured. A bulletin upon the biology and control of the so-called wireworm has been published. A key to the species of cutworms affecting tobacco has also been published, and a bulletin describing means of control is in press. Critical studies have been made of the morphological characteristics of cutworm larvæ and pupæ which will greatly aid field men in determining the species with which they have to deal. A complete bibliography of tobacco insects has been prepared and is being maintained. Considerable data have been secured upon the life history of *Silvanus*.

*Assignment.*—S. E. Crumb, Max Kisliuk, jr., A. C. Morgan, J. U. Gilmore, F. S. Chamberlin.

*Proposed expenditures, 1918-19.*—\$2,400.

**Total, Tobacco Insect Investigations, \$27,840, including \$840 statutory.**

#### RICE INSECT INVESTIGATIONS.

##### Rice Water Weevil and Other Rice Insects:

*Object.*—To investigate the means of control of rice insect pests.

*Procedure.*—Trips of investigation are made to various rice-growing regions to determine insect injury and the influence of various types of farm practice in the control of these pests.

*Cooperation.*—Louisiana Experiment Station.

*Location.*—Points in Louisiana, Arkansas, and Texas.

*Date begun.*—1912.

*Results.*—The control of the rice water weevil by manipulation of water has been worked out at Crowley, La. A large number of notes has been accumulated on the life histories of other rice insects. A complete bibliography of rice insects is maintained at the headquarters at Washington. Two new and important rice pests have appeared in Texas and will require special study.

*Assignment.*—T. E. Holloway.

*Proposed expenditures, 1918-19.*—\$1,000.

(See also Supplement—Emergency Activities, p. 563.)

#### SUGAR-CANE INSECT INVESTIGATIONS.

##### Sugar-Cane Moth Borer:

*Object.*—To discover means of controlling the moth borer in sugar cane and corn, especially in adapting cultural practices to the increase of its parasitic enemies.

*Procedure.*—Thorough experimental work is conducted in Louisiana with all possible means of control. The work has been mainly along the lines of disposition of trash, but this is now being supplemented by the development of a method of control by poisons and by the introduction of foreign parasites. An investigator will spend the summer in Cuba searching for beneficial insects, which will be forwarded to the laboratory at New Orleans for rearing and ultimate release in the sugar-cane fields of Louisiana. The principal available means of control yet to be added is the introduction of a certain valuable parasite from Cuba.

*Cooperation.*—Louisiana Sugar Experiment Station, Audubon Park, New Orleans, La.; Estación Experimental Agronómica, Santiago de las Vegas, Cuba; and various entomologists in tropical countries.

*Date begun.*—1910.

*Results.*—An exhaustive report detailing the life history, seasonal history, and natural control of the moth borer and giving advice as to the best methods of economic control of the species has been submitted for publication. The preliminary experiments with poisoning have been unsatisfactory. The nonburning of trash on large areas has been found beneficial, as it saves the parasites of the borer from destruction.

*Assignment.*—T. E. Holloway, T. C. Barber, E. R. Barber.

*Proposed expenditures, 1918-19.*—\$3,000.



**Miscellaneous Insects Affecting Sugar Cane:**

*Object.*—To determine the damage done to sugar cane by miscellaneous insects, including mealy bugs and root borers, and to perfect means of control.

*Procedure.*—This project is conducted by field examinations, laboratory work, and explorations, as well as by practical experiments. A new laboratory is being installed at Brownsville, Tex., for the study of sugar-cane insects of that section.

*Cooperation.*—Louisiana Sugar Experiment Station, Audubon Park, New Orleans, La., and Estación Experimental Agronómica, Santiago de las Vegas, Cuba.

*Location.*—New Orleans, La., and Brownsville, Tex.

*Date begun.*—1911.

*Results.*—Information has been obtained as to the means of dissemination of sugar-cane insects and as to parasitic enemies.

*Assignment.*—T. E. Holloway; T. C. Barber, E. R. Barber.

*Proposed expenditures, 1918-19.*—\$3,500.

**Total, Sugar-Cane Insect Investigations, \$6,500.**

(See also Supplement—Emergency Activities, p. 563.)

**ARGENTINE ANT INVESTIGATIONS.****Argentine Ant Investigations:**

*Object.*—To reduce losses occurring in cane plantations and orchards and to prevent annoyance in dwellings, warehouses, and elsewhere due to the Argentine ant.

*Procedure.*—Surveys are made of the territory infested in the Southern States, and experiments are conducted to determine control measures suitable for city and plantation conditions.

*Cooperation.*—Louisiana Sugar Experiment Station, Audubon Park, New Orleans, La., and the cities of Hattiesburg, Miss., and Augusta, Me.

*Date begun.*—1910.

*Results.*—The control of the Argentine ant in dwellings, warehouses, and under city conditions generally has been worked out and the results published in Department Bulletin 377.

*Assignment.*—E. R. Barber, T. E. Holloway.

*Proposed expenditures, 1918-19.*—\$2,000.

**Total, Southern Field-Crop Insect Investigations, \$95,360, including \$5,960 statutory.**

[Research.]

**FOREST AND SHADE-TREE INSECT INVESTIGATIONS.****SUPERVISION.****Supervision:**

*Object.*—To supervise the field and laboratory investigations and conduct the necessary administrative and office work incident thereto.

During the fiscal year 1919 and, if necessary, during the period of the war, the work on forest insects will be concentrated on such projects and parts of projects as relate to the following primary features: (1) Investigations of and advice on the conservation of forest resources through the prevention and control of insect depredations on living timber; (2) investigations of and advice on the conservation of forest products through the prevention and control of insect damage to crude and finished material; and (3) investigations of the bioclimatic law of latitude, longitude, and altitude and its application to research and practice in entomology and agriculture.

*Procedure.*—It is planned to defer, during the period of the war, the greater part of the systematic (taxonomic and descriptive) work of the various specialists in order that they may concentrate their time on an intensive study of the seasonal history and biology of the more important economic species of insects. This will not only contribute information essential to rapid progress in forest entomology but will supply some of the most important facts in the investigation of the bioclimatic law.



*Location.*—The office and laboratory work is conducted at Washington and the field work at special field stations representing defined forest areas or districts of the country. The locations of field stations for 1919 are: Colorado Springs, Colo., for the southern Rocky Mountain region; Ashland, Oreg., for the Pacific slope and northern Rocky Mountain region; East Falls Church, Va., for the central and eastern United States; and Lyme, Conn., for the New England States. A field laboratory is located at Los Gatos, Cal., and a temporary field station for the investigation of the bioclimatic law at Kanawha Station, W. Va.

*Date begun.*—1902.

*Assignment.*—A. D. Hopkins.

*Proposed expenditures, 1918-19.*—\$5,400, including \$1,400 statutory.

#### FIELD INVESTIGATIONS.

**(Forest-Reproduction Insects:** Discontinued as a separate project; necessary further work will be conducted under other general and special projects.)

#### **The Bioclimatic Law of Latitude, Longitude, and Altitude in Its Relation to Research and Practice in Entomology and General Agriculture:**

*Object.*—To continue the investigation of the bioclimatic law as applied to research and practice in economic entomology and other branches of science, with the primary object of developing systems and methods of application which will be immediately available to investigators as guides toward the solving of some of the scientific and economic problems relating to entomology, general biology, and agriculture.

*Procedure.*—This is a special project, in which the leader is assisted in the collection of data by all members of the staff in connection with their regular field duties. In the concentration of effort on the study of the seasonal history, biology, and geographical distribution of insects investigations will be continued on the intimately associated periodical phenomena of the plants that are infested by the insects and of other plants which will supply the desired additional facts toward the development of methods of applying the law to the solving of entomological problems. In the investigation of the broader problems of the application of the law to research and practice in agriculture, including insect control, it is planned to continue investigations at the temporary field station at Kanawha Station, W. Va., in order to determine facts in farm practice which are essential to the proper interpretation of local influences in practical application by the farmer.

*Cooperation.*—Weather Bureau and Office of Farm Management (informal).

*Location.*—Washington, D. C., with the United States as the field of operations; temporary field station at Kanawha Station, W. Va.

*Date begun.*—1895.

*Results.*—The investigation of this general subject during the past 23 years has served to reveal and establish the bioclimatic law as a reliable basis or guide to research and practice, but further studies are required to develop methods and systems of application. During 1918 the work on this project was devoted largely to volunteer service by the leader in the interest of increased food supply by making the results of these investigations available for further research and practice, and especially to the practice of growing wheat.

Wheat-seeding map calendar posters were prepared by the leader for 11 of the principal States in which winter wheat is grown as a staple crop. These posters, which were distributed through the county agents by the States Relations Service, enabled the individual wheat grower to select the date and period for his immediate locality which, according to the bioclimatic law, is on the average the safest to escape damage from the fall attack of the Hessian fly and, other things being equal, the best time to seed to secure a maximum yield of grain if the fly was not present.

In addition to the preparation of these posters, a paper entitled "Periodical Events and Natural Law as Guides to Agricultural Research and Practice" was prepared and published as Supplement 9 of the Monthly Weather Review.

*Assignment.*—A. D. Hopkins.

*Proposed expenditures, 1918-19.*—\$6,000.



**(Interrelation of Insects and Forest Fires in the Destruction of Forests and Damage by Insects to the Wood of Fire-Killed Trees:** This project will be suspended until further funds and a trained investigator to work on some of the essential details are available.)

**Insects Affecting Forest Products:**

*Object.*—To determine the character, cause, and extent of injuries to crude, finished, and utilized forest products and methods of preventing losses; the relative immunity of different species of wood to attack by termites and other insects; the relative efficiency of chemical preservatives in the treatment of cabinet and other woods against attack by termites, powder-post beetles, and other wood-boring insects; the relative efficiency of chemical preservatives and methods against insect attack on wood set in the ground; the character and extent of the damage caused by termites and practical methods of prevention and control; powder-post injury to seasoned forest products; and damage to poles, posts, mine props, railroad ties, and similar forest products by wood-boring insects.

*Procedure.*—This is a general project, in which, in addition to the investigations conducted by the leaders, some attention is given to the subject by all members of the staff in connection with their regular field work. The data obtained are submitted to the leaders for study, compilation, and publication. The project includes studies of the character and cause of injuries to recently felled trees, saw logs, round timber, rough timber, and other unseasoned crude products; injuries to seasoned rough and dressed lumber and finished wood material; injuries to construction timbers and other timbers and other wood material used in buildings, bridges, railroad construction, mining, etc.; injury to stored oak and hemlock bark for tanning purposes; injuries to medicinal bark, roots, leaves, etc.; and experiments to determine methods of preventing losses; also investigations of insect galls used for dyes, inks, etc., the insects which produce them, and methods of increasing, collecting, and preserving the products. Special attention is given to investigations and advice with reference to crude and finished products used by the Army and Navy. This involves direct relations with the commissary and supply divisions which have been established.

*Cooperation.*—Manufacturers and utilizers of forest products; also the Bureau of Chemistry in analyzing preservatives, insect galls, etc.

*Location.*—East Falls Church, Va. (field station). Field of operations, United States; and Central and South America, through correspondence.

*Date begun.*—1902.

*Results.*—The results of extensive investigations and experiments with preservatives on different kinds of wood have shown that a large percentage of the serious losses hitherto suffered can be prevented. The recommendations and advice of the bureau have been solicited by the commissary departments of the Army and Navy, and in important cases where the advice has been adopted gratifying results in the prevention of losses of valuable crude and finished products have followed. In like manner, the leading manufacturers of vehicles, farm machinery, etc., have sought advice and followed it with most satisfactory results to them. The recommendations based on detailed studies and experiments with poles set in the ground, mine props, railroad ties, telephone and telegraph poles, etc., are being adopted by electrical, mining, and railroad engineers, and a great saving is being effected thereby.

*Assignment.*—A. D. Hopkins, T. E. Snyder, F. C. Craighead, S. A. Rohwer.  
*Proposed expenditures, 1918-19.*—\$7,000.

**(Hickory Insects:** Discontinued as a separate project. Necessary further work will be conducted in connection with general field and laboratory investigations.)

**(Ash Insects:** Discontinued as a separate project. Suitable remedies for the most important enemies of ash trees and wood products have been developed. General investigations will be continued under "Insects Affecting Forest Products," "Economic Study of Forest Cerambycidae, or Round-Headed Borers," and "Forest Lepidoptera.")



### **Economic Investigations of the Scolytid Bark and Timber Beetles of North America:**

*Object.*—To determine the character and extent of damage caused by these insects to forest growth and forest products, the seasonal histories and habits of the principal species, and practical methods of preventing losses from their attacks.

*Procedure.*—This is a general project, in which the leader is assisted by other members of the field force in connection with their regular field duties, and includes the collection of material of all stages of the insects and their work, with full field notes on observations relating to seasonal histories, habits, and methods of control, experiments with natural enemies, and verification of results. These data are submitted to the leader for study, compilation, and publication.

*Cooperation.*—Department of the Interior and Forest Service, in the investigation and verification of results of practical control work against the *Dendroctonus* beetles in the national parks and national forests.

*Location.*—Washington, D. C., and field stations, with field of operations in all of the forested areas of the United States.

*Date begun.*—1890.

*Results.*—The results of investigations of methods of controlling depredations by bark beetles in the coniferous forests of North America have led to the discovery of practical methods of protecting national, State, and private forests from their most destructive insect enemies. The adoption of the bureau's recommendations based on this discovery has resulted in an estimated saving of not less than \$10,000,000 annually in the value of timber protected, at comparatively little cost.

The *Dendroctonus* beetles have continued to be a menace to the standing pine, spruce, and Douglas fir timber of the Rocky Mountain and Pacific-coast States wherever control measures have not been adopted and carried out to prevent the spread of local outbreaks, and in the aggregate many millions of dollars worth of the best timber has been lost, but wherever the methods that have been determined and advised by this bureau have been adopted and carried out most gratifying results have followed. Especially is this marked in and adjacent to areas where control work has been done in past years in Colorado, Montana, Wyoming, Oregon, and California.

The percentage principle of control has stood the test of another year and appears to be one of the most important practical results attained in the forest-insect work, and much additional and confirmatory data have been secured on the host selection principle as related to the economy of insect control.

*Assignment.*—A. D. Hopkins.

*Proposed expenditures, 1918-19.*—\$6,000.

### **Economic Study of Forest Buprestidæ, or Flat-Headed Borers:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Location.*—Los Gatos, Cal. (field laboratory); field of operations, United States.

*Date begun.*—1904.

*Results.*—It has been determined that some of the flat-headed borers are primarily destructive to living trees, while others contribute to the death of weakened trees or are destructive to the wood of living and dead timber, and that a large percentage of the losses can be prevented through a practical application of the information already acquired and published. Special progress has been made in the investigation of seasonal histories and habits of many species of flat-headed borers and methods of controlling them. An example of special interest is the investigation of serious damage to plantations of "Australian pine" in Florida by a species of flat-headed borer (*Chrysobothris impressa* Fabr.) which normally breeds in mangrove. As a result of the investigation methods of control have been developed and adopted by the principal growers.

Special progress has been made in the studies of *Agrilus* beetles on the Pacific coast and in the development of methods of controlling the more important species. It has been determined that the oak twig girdler (*Agrilus angelicus*), which kills the twigs and small branches on the



live oak in California, can be controlled by collecting and burning the infested twigs.

The menace to the oaks on Long Island, N. Y., by the two-lined chestnut borer (*Agrilus bilineatus*) has evidently been reduced to a minimum through the adoption of the methods recommended in connection with the instruction and demonstration work carried on there during the past two years.

*Assignment.*—H. E. Burke, T. E. Snyder, W. S. Fisher.

*Proposed expenditures, 1918-19.*—\$3,000.

### **Economic Study of Forest Cerambycidae, or Round-Headed Borers:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project, except that this is a special project.

*Location.*—East Falls Church, Va. (field station); field of operations, United States.

*Date begun.*—1904.

*Results.*—The results of a special study of this class of bark and wood borers have shown that they are far more destructive than was heretofore supposed. Special progress has been made in the acquiring of new information on the seasonal history and habits of a large number of species and in the development of remedies. A result of exceptional value and importance is the successful experiments with poisoned kerosene emulsion and other contact insecticides against the locust borer in some large plantations. This resulted in the killing of from 90 to 95 per cent of the young larvæ before they entered the wood, at a comparatively small cost, and showed that plantations of black locust which have heretofore failed on account of the borer can now be successfully maintained, and thus add greatly to the supply of one of our most important wood products.

The oak shade and forest trees of the Southern States have suffered severely from the attack of the Romuleum oak borer in the main trunks and the Prionus root borer in the roots. The special investigations and experiments carried on have resulted in the determination of many new facts relating to the insects and methods of protecting the trees against their destructive work.

*Assignment.*—F. C. Craighead.

*Proposed expenditures, 1918-19.*—\$3,100.

### **Economic Study of Beneficial Forest Insects:**

*Object.*—To determine the character and extent of beneficial influences of parasitic and predatory insects, their histories and natural enemies, and methods of propagating and encouraging their beneficial work; and to secure the importation of foreign species and the artificial dissemination of native species.

*Procedure.*—Same as preceding project, except that this is a general project.

*Location.*—Lyme, Conn., and East Falls Church, Va. (field stations); field of operations, United States.

*Date begun.*—1903.

*Results.*—Many new facts have been determined regarding the principal parasitic and predacious insects which are the natural enemies of injurious insects, and this information has been of special importance in connection with the practical application of artificial methods of control. Special progress has been made in the new feature taken up last year on the investigation of gall insects, viz, to determine the relative value of American galls for dyes and inks as compared with the Aleppo galls of China. The Bureau of Chemistry is assisting in this work by analyzing the various galls submitted by the specialists assigned to the project.

*Assignment.*—A. D. Hopkins, A. B. Champlain, S. A. Rohwer, Adam Boving.

*Proposed expenditures, 1918-19.*—\$3,000.

### **Bark Lice of the Genus Chermes:**

*Object.*—The determination of systematic and bionomic facts relating to the species of Chermes which infest the bark of coniferous and other forest trees, with special reference to the species involved, their life history and habits, and methods of combating them.

*Procedure.*—Same as preceding project.

*Location.*—United States.



*Date begun.*—1908.

*Results.*—It has been found that this class of insects, each species of which lives alternately on two different species of trees, making galls on the twigs of spruce and infesting the twigs and bark of pine, is of special economic importance. It has been discovered that if nursery and ornamental trees are sprayed with kerosene emulsion at the time new growth starts on the twigs it will protect the trees from damage by this class of insects. Special progress has been made in this line of investigation, especially on the species affecting western conifers, including the discovery of many new facts. Experiments with kerosene emulsion and nicotine sulphate on spruce and pine at Colorado Springs, Colo., showed that both of these contact sprays were effective remedies against the bark and gall lice.

*Assignment.*—A. D. Hopkins, J. H. Pollock, Jacob Kotinsky.

*Proposed expenditures, 1918-19.*—\$1,000.

**(Agrilus Beetles:** Discontinued as a separate project; included under "Economic Study of Forest Buprestidæ, or Flat-Headed Borers," and "Economic Study of Beneficial Forest Insects.")

**(Relation of Mistletoe on Living Trees to Attack by Insects:** Discontinued as a separate project; necessary further work to be conducted in connection with general field and laboratory investigations.)

### **Insect-Control Instructions and Demonstrations in the National Parks and National Forests:**

*Object.*—To give instructions on the essential practical details and to conduct demonstration projects on the control of *Dendroctonus* beetles in national parks and national forests in accordance with principles and methods recommended by the Bureau of Entomology.

*Procedure.*—This is a special demonstration and instruction project, in which the Department of the Interior and the Forest Service detail rangers to the Bureau of Entomology to receive instructions from an entomological ranger of this bureau, who has been trained as an expert on the practical details of cruising and locating infested timber and in the application of measures advised by the leader of this project. The instructions relate specifically to (a) methods of cruising to locate the infested timber requiring treatment, (b) the essential practical details of conducting the work of control and protection against *Dendroctonus* beetles, (c) the inspection of areas in which control work has been done, (d) the location of areas requiring treatment, (e) estimating the character and extent of insect-killed or infested timber, and (f) advice on such other matters pertaining to the practice of forest entomology as may be deemed necessary. All entomological matters except the minor questions that can be handled by the insect-control expert will be referred by him either to a local entomological expert of the Branch of Forest Insects, Bureau of Entomology, or to the chief of the branch at Washington for advice or recommendations. The Bureau of Entomology pays the salaries of the entomological rangers. The Department of the Interior and the Forest Service pay their traveling and field expenses and also the salaries and expenses of their rangers assigned to the work and the expenses of all cruising and control operations. When the park and forest rangers are sufficiently trained and qualified, they are designated as insect-control rangers and assigned to a national park or national forest to work under the immediate supervision of the park or forest supervisor or superintendent.

The attention to this subject in 1918-19 will be mainly in the line of recommendations and instructions in the Sequoia National Park and Sequoia National Forest.

*Cooperation.*—National Park Service, Department of the Interior; and Forest Service.

*Location.*—Washington, D. C., and Ashland, Oreg.

*Date begun.*—1913.

*Results.*—This work has resulted in verifying and demonstrating the practicability and efficiency of the percentage principle of control. The Yosemite Valley is now practically free from damage. Special interest has been aroused among the principal private owners of timber in California, who have requested a survey of the State to ascertain the character and extent of the depredations by *Dendroctonus* beetles and to develop



methods of control. A special informal arrangement between the private owners, the Bureau of Entomology, the Forest Service, and the National Park Service of the Interior Department has also been effected, whereby a representative of the Bureau of Entomology has been charged with the general supervision of the work, the pro rata field expenses involved to be borne by the directly interested private owners and public service.

*Assignment.*—A. D. Hopkins, J. M. Miller.

*Proposed expenditures, 1918-19.*—\$4,000.

### **Investigation of Insects Affecting Shade Trees and Hardy Shrubs:**

*Object.*—To determine (a) the general character and extent of damage by insects to the trees and shrubs of public and private grounds, including municipal parks, streets, cemeteries, country roads, private parks, national cemeteries, etc., (b) additional facts on the seasonal histories and habits of the insects involved, and (c) additional facts on practical methods of prevention and control; to conduct experiments, and finally to give advice through correspondence, publications, and otherwise, on the principles and methods of control to meet the requirements of specific insects and local conditions.

*Procedure.*—This is a general project, to which members of the regular field and laboratory force give more or less attention, collecting material and studying and identifying insects. The small allotment of funds available for this work renders the field of operations so limited that very little can be accomplished except along restricted lines of investigation.

*Cooperation.*—Some informal cooperation with municipalities, Federal and State officials, and owners of private parks and grounds will be invited, looking to their adoption of the most economical and effective methods of prevention and control, the conduct of experiments with new methods, and the verification of results in practice.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—Recent observations and inquiries indicate that the amount of money expended by municipalities and wealthy owners of private grounds and parks each year on useless or improperly applied methods of combating insects affecting shade trees and ornamental shrubs represents a greater loss than that caused directly by the insects. Observations and experience also indicate that, if the proper methods of prevention and control are adopted and carried out in accordance with advice from the most reliable sources, the waste of money and the damage and annoyance from the insects will be reduced to a minimum. Much assistance has been rendered, by way of advice through correspondence, in connection with shade-tree problems.

The work of the field laboratory at Los Gatos, Cal., has been directed to the investigation of local problems, one receiving special attention being a study of the defoliation of oak shade trees by caterpillars. An aphid on walnut shade trees at Los Gatos, Cal., has proved troublesome in that its attacks result in the pavements and streets becoming slippery by reason of the quantities of honeydew exuded. Spraying the trees with nicotine sulphate proved to be a successful means of eliminating the trouble.

As a result of extensive instruction and demonstration work on Long Island, N. Y., during the past two years, a serious menace to the hickory and oak shade and forest trees of the island has been effectively removed through the activity of property owners in carrying out the recommended method of cutting and utilizing or otherwise disposing, during the fall, winter, and early spring, of a majority of the trees that died the preceding summer.

*Assignment.*—A. D. Hopkins, H. E. Burke, Jacob Kotinsky.

*Proposed expenditures, 1918-19.*—\$4,000.

**Total, Field Investigations, \$37,100, including \$3,120 statutory.**

### **LABORATORY INVESTIGATIONS.**

The work under this group has special reference to original research on the more technical features of the science of forest entomology and has



yielded some of the most important results in the line of essential and fundamental information on which to base economic research and practice.

### **Forest and Other Scolytidæ:**

*Object.*—To (a) determine, classify, and describe the genera, species, and stages of development which are new to science; (b) revise and bring up to date the systematic knowledge of all North American species; (c) investigate problems relating to anatomy, taxonomy, terminology, and nomenclature; (d) determine seasonal histories, food and breeding habits, geographical distribution, and such other information of a technical nature about the species as is essential to the best success in the investigation and practical treatment of economic problems.

*Procedure.*—This is a special project, in which specimens of all stages of the insects and their work are collected by the leader and members of the force in connection with their regular field duties from all parts of the United States or are received by exchange or for identification from all parts of the world. These specimens are labeled, classified, and preserved in a separate collection in the National Museum with the collection of forest insects under the custodianship of the leader. Such time as can be spared from the regular administrative duties is devoted to a systematic study of the material and the literature on the subject and to the preparation of manuscript for permanent record and publication.

*Location.*—Washington, D. C.

*Date begun.*—1902.

*Results.*—The results of the systematic work on this group of insects have shown that previous to the leader's work on this group nothing whatever had been known of a large number of the most destructive insect enemies of North American forest trees. The information acquired has made it possible to study their exact economic relations to the trees and to discover practical methods of control and prevention. The value of the results of this work alone may be estimated in tens of millions of dollars toward the practical conservation of the forest resources of the United States. The collections are the largest in the world, and specimens are sent here from many other countries for authentic identification.

*Assignment.*—A. D. Hopkins.

*Proposed expenditures, 1918-19.*—\$1,000.

### **Forest and Other Buprestid Larvæ:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Location.*—Los Gatos, Cal. (field laboratory); field of operations, United States.

*Date begun.*—1904.

*Results.*—Heretofore practically nothing was known of the systematic characters by which the larvæ of various species of this class of insects could be identified, and without this knowledge very little could be accomplished in the study of seasonal histories and habits, and practically nothing could be done toward the discovery of effective methods of control. Special progress has been made in this work in the discovery of new facts of economic importance.

*Assignment.*—H. E. Burke.

*Proposed expenditures, 1918-19.*—\$1,000.

### **Forest and Other Cerambycid Larvæ:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Location.*—Washington, D. C.; field of operations, United States.

*Date begun.*—1904.

*Results.*—Exceptional progress has been made in the investigation of these larvæ. While they are of great economic importance, very little was known about them a few years ago. Now more than 250 species have been identified and a fund of information acquired of great scientific and economic value. Special progress has been made in the preparation of important manuscript for publication.

*Assignment.*—F. C. Craighead.

*Proposed expenditures, 1918-19.*—\$2,550.



**Forest Hymenoptera:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Location.*—Washington, D. C.; field of operations, United States.

*Date begun.*—1909.

*Results.*—The results of systematic work on this group of insects, which includes both injurious and beneficial species, are of special scientific and economic importance. Without the knowledge gained from such a study it would be impossible to arrive at definite conclusions as to the relation of the beneficial insects to natural control or to profit by their beneficial influence in connection with the practice of artificial methods of combating insects. Many publications have been issued during the past year in technical and other journals.

*Assignment.*—S. A. Rohwer, William Middleton.

*Proposed expenditures, 1918-19.*—\$2,000.

**Forest Lepidoptera:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Location.*—Washington, D. C.; field of operations, United States.

*Date begun.*—1912.

*Results.*—Until recent years this important group of forest insects had been almost neglected in this country, but now that a specialist is working on it rapid progress is being made and information acquired which is of fundamental importance to the field investigations of economic problems. Large additions have been made to the collection, and special progress has been made on the *Evetria* group of tip and pitch moths. A striking example of the practical value of purely systematic research is found in an intensive systematic study by the leader of this project of the arrangement of the hairs on the heads of different species of Lepidopterous larvæ. As a direct result of this study the fragments of a larva taken from cotton seed were positively identified as the dreaded pink bollworm of Egypt and Hawaii and led to immediate steps toward the prevention of its introduction and establishment in this country.

*Assignment.*—Carl Heinrich.

*Proposed expenditures, 1918-19.*—\$2,000.

**Forest Coleoptera:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Results.*—This group of insects is represented by more species of economic importance than any other, and therefore requires special study and the proper arrangement and care of the collections, in which considerable progress has been made.

*Assignment.*—W. S. Fisher.

*Proposed expenditures, 1918-19.*—\$2,000.

**Forest Diptera:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Results.*—Very little has been known of this group of insects in their relation to forest growth in America; hence the necessity of systematic work as a basis for economic investigations. Some important discoveries have been made during the past year and a large number of specimens added to the collection.

*Assignment.*—C. T. Greene.

*Proposed expenditures, 1918-19.*—\$1,000.

**Forest and Other Isoptera:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Location.*—Washington, D. C.; field operations, United States.

*Date begun.*—1912.

*Results.*—The results of work on the white ants of North America have shown that they are of special economic importance, causing, as they do,



great damage to buildings, poles, posts, construction timber, etc. It has been found that there is special need for detailed systematic study of the species as a basis for effective economic work.

As a result of an extensive preliminary survey made through the Gulf, Rocky Mountain, and Pacific coast States to study our native termites, a large number of specimens of termites were collected, with biological data and notes on the injury caused by them. These notes have been worked up and, in collaboration with Mr. N. Banks, of the Museum of Comparative Zoology, Cambridge, Mass., a paper entitled "A Revision of Nearctic Termites, with Notes on Their Geographical Distribution and Biology," has been submitted for publication, Mr. Banks preparing the systematic portion. This deals with 33 species and one variety, 16 of the species and the variety being new to science. Breeding experiments with the three different forms of reproductive individuals have been conducted, and, in collaboration with Dr. C. B. Thompson, of Wellesley College, Wellesley, Mass., a paper has been submitted for publication on these forms and their progeny.

*Assignment.*—T. E. Snyder.

*Proposed expenditures, 1918-19.*—\$2,000.

#### **Forest and Other Coleopterous Larvæ:**

*Object.*—Same as preceding project.

*Procedure.*—Same as preceding project.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Results.*—Practically nothing was known of the immature stages of even the common beetles which infest the forest trees of this country and their products previous to the inception of these studies. The results so far attained show the absolute necessity of this work as a basis for economic investigations. Special progress has been made on this important line of research during the past year, and some 400 pages of manuscript have been prepared, with many illustrations, which, when published will advance the knowledge of this subject far beyond that of any preceding publications on the subject, especially as regards American species.

*Assignment.*—Adam Boving.

*Proposed expenditures, 1918-19.*—\$2,500.

**Total, Laboratory Investigations, \$16,050, including \$4,160 statutory.**

**Total, Forest and Shade-Tree Insect Investigations, \$58,550, including \$8,680 statutory.**

[Research.]

### **TRUCK-CROP INSECT INVESTIGATIONS.**

#### **SUPERVISION.**

##### **Supervision:**

*Object.*—To supervise and direct investigations of insects injurious to vegetable and truck crops, including laboratory and field work and the general office routine incidental thereto.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—F. H. Chittenden.

*Proposed expenditures, 1918-19.*—\$9,200, including \$5,640 statutory.

#### **POTATO INSECT INVESTIGATIONS.**

**(Potato-Tuber Moth: Project completed; information published in Department Bulletin 427.)**

##### **Potato Flea-Beetle:**

*Object.*—To investigate points hitherto unknown in the life history of this pest, ascertain the number of generations, and devise effective remedies against the serious injury to potatoes which normally results through its attacks.

*Procedure.*—This insect is a serious enemy of potatoes throughout the Northern States, the adult defoliating the vines, while the larva is the cause of "pimply potatoes," especially through the section including



New York, New Jersey, and Pennsylvania. The establishment of a station at Riverton, N. J., and one in Aroostook County, Me., will afford effective means of studying necessary points in the life history of the flea-beetle, with a view to its control, since considerable injury through this pest is of annual occurrence in that region and present-known control measures are inadequate.

*Cooperation.*—New Jersey Agricultural Experiment Stations.

*Location.*—Riverton, N. J., and Aroostook County, Me.

*Date begun.*—1912.

*Results.*—Considerable information has been accumulated on the life habits and economy of this pest in its occurrence in different regions, but, although it has been the subject of experiment for many years, a really efficient remedy remains to be found. The protection of the plants with Bordeaux mixture has a deterrent effect on the insect, and the destruction of all Solanaceous weeds is of great value.

*Assignment.*—D. E. Fink, C. H. Batchelder.

*Proposed expenditures, 1918-19.*—\$2,000.

### **Colorado Potato Beetle and General Potato Insect Pests:**

*Object.*—To secure additional information with regard to the numerous enemies of the potato, such as the Colorado potato beetle, potato aphid, spinach aphid, potato stalk weevil, potato leafhopper, white grubs, and wireworms. It is particularly desirable to continue a campaign in the South, in which insecticides applicable for use in countries of extreme precipitation or moisture, such as the Louisiana Delta, may be tested. The spread of the Colorado potato beetle on the Pacific coast will also be investigated.

*Procedure.*—At the various field stations of this bureau practical control experiments with new and standard insecticide preparations are being made and additional points in the life history of the pests investigated, and tests of new insecticide machinery are under way.

*Cooperation.*—Louisiana Experiment Station.

*Location.*—Baton Rouge, La., Aroostook County, Me., and New Jersey.

*Date begun.*—1907.

*Results.*—In the past the Colorado potato beetle has been unrestricted in some regions because of the lack of the application of appropriate scientific remedies, and injury has, on this account, been considerable. Although many years ago the Bureau of Entomology directed proper methods of control, correspondence constantly received indicates that this matter is still misunderstood. The conditions incident to the war have also rendered such compounds as Paris green almost prohibitive in price. On this account other and cheaper insecticides are recommended. Farmers' Bulletin 868, "Increasing the Potato Crop by Spraying," prepared in conjunction with the Bureau of Plant Industry, has been issued. This bulletin gives the principal necessary information in regard to the control of the Colorado potato beetle, blister beetles, flea-beetles, cutworms, leafhoppers, and plant-lice.

*Assignment.*—T. H. Jones, D. E. Fink, C. H. Batchelder.

*Proposed expenditures, 1918-19.*—\$3,710.

**Total, Potato Insect Investigations, \$5,710.**

### **ONION INSECT INVESTIGATIONS.**

#### **Onion Insect Investigations:**

*Object.*—To obtain information regarding various onion insects, with special reference to root-maggot injury, and to study the methods of hibernation, alternate food plants, natural enemies, and life histories of the serious insect pests of onions.

*Procedure.*—The life histories of onion pests are worked out under field conditions, and practical applications of insecticides, repellents, fertilizers, and other materials are made, in order to furnish information as to those most useful.

*Cooperation.*—Wisconsin Agricultural Experiment Station.

*Location.*—South Texas and Wisconsin.

*Date begun.*—1907.

*Results.*—A thorough study of the onion thrips has been made and complete results are available for publication. With regard to this pest, it is esti-



lated that \$1,000,000 was saved to the onion growers of northern Indiana through the application of control measures devised and demonstrated by members of the staff of the Bureau of Entomology. A complete treatise on this pest will soon be available. A Farmer's Bulletin covering the main subject of remedies is available for the printer. Tests of various materials suitable for repellents against the onion maggot and other root-maggots were made experimentally in Wisconsin during the past fiscal year, but the project, being peculiarly difficult, will require considerable additional study.

*Probable date of completion.*—1921.

*Assignment.*—M. M. High, J. E. Dudley.

*Proposed expenditures, 1918-19.*—\$2,250.

#### CRUCIFER INSECT INVESTIGATIONS.

##### Crucifer Insect Investigations:

*Object.*—To investigate the life history of and control measures applicable to the cabbage looper, cabbage webworms, cabbage stalk weevil, and various aphides and thrips in connection with their attack on cruciferous crops, such as cabbage, cauliflower, and turnip; and to complete studies on the vulnerable points in the life history of the harlequin cabbage bug, root-maggots, the cabbage flea-beetles, and other cabbage pests.

*Procedure.*—Extensive investigations are made in districts which grow cole crops commercially, and life-history studies looking to better methods of control of the more serious pests encountered are made, especially with reference to the application of remedial measures in the field and to the determination of the most effective insecticides and the time they may be applied to the best advantage. The introduction of natural enemies of crucifer insects is undertaken and control by the application of repellents and cultivation demonstrated.

*Cooperation.*—Wisconsin Experiment Station.

*Location.*—Vashon, Wash., Madison, Wis., and Riverton, N. J.

*Date begun.*—1907.

*Results.*—Control experiments of the root-maggots attacking cabbage, cauliflower, turnips, and other crucifers through the use of newly devised repellents have yielded promising results. The cabbage aphid is almost completely under control in Virginia as a result of the introduction of beneficial ladybirds. The control of the cabbage looper, the imported cabbage worm, and the onion thrips in its occurrence on cabbage has also been effected, and the rôle of cabbage and other crops as alternate host plants for the onion thrips has been definitely ascertained. These results are being adapted for practical use in cabbage-growing sections of the United States. A publication on the western turnip flea-beetle is available for publication. A Farmers' Bulletin covering the principal cabbage pests is in course of preparation.

*Assignment.*—D. E. Fink, J. E. Dudley, W. T. Ham.

*Proposed expenditures, 1918-19.*—\$3,600.

#### BEAN AND PEA INSECT INVESTIGATIONS.

##### Investigations of Bean and Pea Insects:

*Object.*—To obtain further information with regard to the control of the pea aphid and bean aphid, bean leaf-beetle, and other insects on large commercial plantings of peas.

*Procedure.*—Well-equipped field laboratories have been established in California and Louisiana for the study of appropriate control measures through the application of contact insecticides and the encouragement of natural enemies.

*Location.*—Baton Rouge, La., and southern California.

*Date begun.*—1907.

*Results.*—The life history of the pea aphid has been thoroughly understood for some time in regard to its occurrence in small market gardens, and measures for its control are readily and successfully applied, but on large commercial plantings of peas, especially when sown broadcast, further experiments in control measures will be undertaken.



A particularly difficult problem has recently been experienced in the control of the bean leaf-beetle in Louisiana, where local atmospheric conditions necessitate material changes in the procedure adapted to general control measures against this pest. A bulletin on the bean ladybird, a serious pest in the Southwest, is nearing completion. A second publication on the southern green plant-bug, which does considerable injury to beans in the Gulf States, is in the printer's hands.

*Assignment.*—Thomas H. Jones, R. E. Campbell.

*Proposed expenditures, 1918-19.*—\$1,750.

**(Investigation of Pea Aphis:** Discontinued as a separate project; included under "Investigations of Bean and Pea Insects.")

#### CUCURBIT INSECT INVESTIGATIONS.

##### Insects Which Transmit Cucumber Diseases:

*Object.*—To investigate the insects injurious to cucumber and related crops and to develop and test methods of control, with particular attention to those insects which transmit the infection of bacterial wilt, mosaic, and other diseases; and to cooperate with the Bureau of Plant Industry in an investigation of the transmission by insects of such diseases.

*Procedure.*—Field and laboratory work is conducted in conjunction with experiments of the Bureau of Plant Industry at Madison, Wis., and Plymouth, Ind. The project relates at its present stage mainly to troubles which affect cucumbers grown for pickling in the Great Lakes region. Experimental plats of approximately 1 acre each for the test of different insecticides have been established at these stations, where a series of spray tests with different chemicals is being conducted in order that the most effective insecticide and the one causing the least injury to the plants may be selected for future demonstration and advice to growers. Similar work has been begun and will be continued, if possible, at Muscatine, Iowa. An assistant has been placed at each station to help in the recording of results from the plat work and in the application of sprays to the larger fields.

*Cooperation.*—Wisconsin Experiment Station, Bureau of Plant Industry, and individual growers.

*Location.*—Madison, Wis., and Muscatine, Iowa.

*Date begun.*—1916.

*Results.*—Two seasons' work on the subject of insects which transmit cucumber diseases has resulted in placing the responsibility, to a large extent, on the striped cucumber beetle as the principal disease carrier, and points hitherto unknown in the life history of this insect have been developed which appear to have established a new line of investigation as to the probable agency of the beetle in the overwintering of the disease. Exhaustive studies are therefore being initiated regarding the hibernation of disease-infected beetles and their ability to continue disease outbreaks. The work on insecticides applicable to the control of the pest is also being crystallized to include only those of the large number tested which are capable of producing effective results.

*Assignment.*—J. E. Dudley, M. R. Smith, F. M. Wadley.

*Proposed expenditures, 1918-19.*—\$5,000.

**(Melon Aphis and Related Forms:** Discontinued as a separate project; included under "General Cucurbit Insects.")

**(Pickle and Melon Worms:** This is a minor project which has been temporarily suspended until a trained investigator to undertake the work is available.)

##### General Cucurbit Insects:

*Object.*—To devise more effective and less expensive methods of controlling the melon aphis on large commercial plantings of cucumbers and melons; to determine better means of control for the pickle and melon worms in the South to be based upon further investigations of their life history.

*Procedure.*—Since the life history of the melon aphis has been the subject of recent publications, present experiments are intended chiefly to deal with control measures applicable to large irrigated fields in the South and West. Applications of new and standard insecticides are made with



high-pressure engine-driven machinery, with the view of attaining thorough distribution of contact insecticides over infested plants.

*Location.*—Baton Rouge, La., and Alhambra, Cal.

*Date begun.*—1908.

*Results.*—Nicotine sulphate in combination with soaps has been found a cheap and effective remedy for the control of the melon aphid on small plats. Special machinery has been devised for the practical application of insecticides at extreme high pressure, so that colonies previously protected by the leaves may be treated. The introduction of ladybird beetles has proved an effective remedy in some regions. Publications covering the more important details of a biological nature and the remedies most readily applicable has been issued. The life history of a newly introduced squash bug of economic interest has been worked out, and the results will soon be available for publication. Other similar publications are in preparation.

*Assignment.*—R. E. Campbell, T. H. Jones.

*Proposed expenditures, 1918-19.*—\$1,500.

**Total, Cucurbit Insect Investigations, \$6,500.**

#### SUGAR-BEET INSECT INVESTIGATIONS.

##### Sugar-Beet Leafhoppers:

*Object.*—To obtain exact information regarding the life histories, alternate food plants, and means for the control of leafhoppers injurious to sugar beets, including the very destructive curly-top leafhopper, a pest which in some seasons totally destroys the sugar-beet crop in restricted localities and which is distributed over the entire Great Plains regions and the Pacific coast.

*Procedure.*—A comprehensive study is being made of the life history of the pest in its occurrence on alternate wild host plants, of the effect of the attack on sugar beets, and of the best means for its control. The treatment of large acreages of sugar beets by means of sprays has proved ineffective, and a study of wild host plants is necessary in order to promote control by clean culture. The effect on the plant is being studied both under field conditions and through the silage of beets attacked the previous year, in order to ascertain the toxic effect of the leafhopper puncture on the flowering organism. A determination of the exact factors which have caused the regular outbreaks of this pest in widely separated localities throughout the Rocky Mountain region is being made in localities where the leafhopper is regularly present through the abundance of its natural food plants.

*Cooperation.*—Sugar-beet factories where stations are located.

*Location.*—Spreckels, Riverside, and Oxnard, Cal.

*Date begun.*—1909.

*Results.*—The sugar-beet leafhopper, which annually destroys from 50 to 90 per cent of the beet crop in widely separated localities, has been studied in Utah and Idaho, and preliminary accounts have been published. Work has been undertaken in California with the result that a considerable number of alternate host plants have been discovered. Parasites from Hawaii have been liberated in infested localities.

*Probable date of completion.*—1920.

*Assignment.*—C. F. Stahl, R. E. Campbell.

*Proposed expenditures, 1918-19.*—\$2,250.

##### General Sugar-Beet Insects:

*Object.*—To make experiment in the control of the sugar-beet wireworms, and to conduct tests on the control of beet leaf-beetles, beet flea-beetles, false chinch bugs, root-aphis, webworms, white grubs, leaf-miners, grasshoppers, and other insect enemies of sugar beets.

*Procedure.*—The usual methods of investigating the life histories and control of the pests mentioned are followed. The hibernation of many sugar-beet insects offers a vulnerable point of attack and is the constant subject of experiment in the Rocky Mountain and Pacific regions, especially with regard to clean cultural methods and the removal from infested fields of refuse sugar beets in the case of wireworms. Control by insecticides is also established. Life histories of many of these pests are worked out and observations conducted on others.



*Cooperation.*—State stations in California.

*Location.*—Alhambra, Spreckles, and Oxnard, Cal., and Greeley, Colo.

*Date begun.*—1908.

*Results.*—The sugar-beet webworm has been effectively controlled by the application of arsenical sprays. The beet leaf-beetle may be effectively destroyed during the winter by burning large bunches of panic grass, which grows in waste places about beet fields, under which they hibernate. This method has been adopted by growers, with the result that beets are practically free from injury from this insect at the present time. Control measures for the beet wireworms have been developed and demonstrated, and results are soon expected from work on the beet root-aphis. A report on the principal beet-feeding grasshoppers has been completed and published as Farmers' Bulletin 691. The life histories of many minor beet pests have been investigated.

*Assignment.*—R. E. Campbell, C. F. Stahl, A. E. Mallory.

*Proposed expenditures, 1918-19.*—\$2,750.

**Total, Sugar-Beet Insect Investigations, \$5,000.**

#### BERRY INSECT INVESTIGATIONS.

##### Berry Insects:

*Object.*—To investigate the more injurious insect enemies of such small fruits as are cultivated as truck crops, including strawberry, raspberry, blackberry, dewberry, and loganberry. Investigations are to be conducted on the strawberry crown borer, two species of weevils which affect the roots of this plant, the strawberry weevil, and various species of leaf-rollers, the scale insects of raspberry, the raspberry fruitworm, the raspberry cane-borer, and the blackberry stem-gall.

*Procedure.*—Investigation will be undertaken in Louisiana and New Jersey, where several of the more injurious strawberry pests have appeared and where a considerable opportunity is afforded for studies of blackberry and raspberry insect pests.

*Cooperation.*—Louisiana and New Jersey experiment stations.

*Location.*—Baton Rouge, La., Muscatine, Iowa, and Riverton, N. J.

*Date begun.*—1907.

*Results.*—The life histories of a number of the more important pests are available for publication or have already been the subject of Department Bulletins. Additional work on control measures for a number of species will materially aid in the elimination of these pests as important factors in the growing of berries. Spray tests on leaf-rollers have resulted in effective control.

*Assignment.*—T. H. Jones, D. E. Fink, F. M. Wadley.

*Proposed expenditures, 1918-19.*—\$1,790.

#### INVESTIGATION AND CONTROL OF THE SWEET-POTATO WEEVIL.

##### Investigation and Control of the Sweet-Potato Weevil:

*Object.*—To investigate the life history, habits, and distribution of the sweet-potato weevil, and to develop appropriate remedial measures for its control and eradication.

*Procedure.*—Field laboratories for the investigation of the life history and habits of the sweet-potato weevil have been established in Florida and Texas. Control measures will be undertaken in both these States, as well as at Ocean Springs, Miss., and New Orleans, La. Experiments will also be undertaken to determine the most suitable means of control under particular local conditions. A staff of inspectors is maintained in each State involved, with instructions to determine, through a close farm-to-farm canvass, all farms now infested by the weevil. Agreements are now in effect with the infested States whereby State leaders from the forces available for regulatory activities have been designated to cooperate with the department in this work. This arrangement provides for the necessary control, through quarantine, and for the establishment, according to State laws, of forces available for actual destruction of infested material as an eradictory measure.

*Cooperation.*—States of Florida, Georgia, Alabama, Mississippi, Louisiana, and Texas.

*Location.*—Washington, D. C., Macclenny, Fla., Silver Hill, Ala., Ocean Springs, Miss., New Orleans, La., and Kingsville, Tex.



*Date begun.*—1918.

*Results.*—Some preliminary work has already been accomplished in determining through a close survey the approximate boundaries of the infested areas in the States affected, and steps have been taken to provide against the continued dissemination of the weevil through the adoption and enforcement of quarantines by the various States concerned, in cooperation with the field agents of the Bureau of Entomology. Experimental work along control lines, as yet of a preliminary nature, has been conducted in southern Texas and northern Florida. A number of host plants have been discovered from which reinfestation might take place, and information in regard to the best methods of control is being furnished through special field agents and State officials, posters, and circular letters, as well as through correspondence and informal talks in the infested regions of the States mentioned.

*Assignment.*—F. H. Chittenden, John E. Graf, C. H. Popenoe.

*Proposed expenditures, 1918-19.*—\$20,000.

(See also Supplement—Emergency Activities, p. 562.)

#### GENERAL VEGETABLE AND TRUCK-CROP INSECT INVESTIGATIONS.

##### General Vegetable and Truck-Crop Insects:

*Object.*—To control the insect enemies of vegetable and truck crops not covered by specific projects, including garden vegetables, such as asparagus, table beets, spinach, celery, parsnip, and related plants, tomato, eggplant, sweet potato, pepper, rhubarb, lettuce, and other salad plants, salsify, okra, condiments, herbs, and medical plants; to test control methods commercially and in small plats, such as kitchen gardens; and to conduct similar work on mushroom insects. Among the most important insects which come under this heading are the asparagus beetles and miner, leafhoppers, flea-beetles, spinach aphis, loopers, stalk-borers, tarnished plant-bug, corn earworm or tomato fruitworm, sweet-potato tortoise beetles and sawflies, and rhubarb curculio. As a part of this miscellaneous or unclassified work will be the handling of the natural enemies of insects attacking various crops, including ladybirds and parasites which control aphides or plant-lice, parasitic enemies of the looper, and others. This line of work will be continued and the natural enemies introduced at new points where they can act as destroyers of host insects or pests.

*Procedure.*—This project will be carried on where possible in the District of Columbia and at near-by points in Maryland and Virginia, including a plat at the Arlington Farm, as well as in practically all of the stations of this branch of the bureau.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Washington, D. C., Arlington Farm, Va., and the experimental stations of this office.

*Date begun.*—1907.

*Results.*—The life histories of many of these pests have been studied, investigations conducted on control measures, and many of the problems under this head nearly completed. Practical work has been done on such insects as thrips, red spider, spinach aphis, and other plant-lice, which has resulted in the suppression of the worst pests in the important trucking regions. Preliminary work has been conducted on mushroom insects and the results published as Farmers' Bulletin 789. A Farmers' Bulletin covering the control of the principal slugs or shell-less snails and a paper on the life history of one of our commonest cutworms have also been issued. An account of springtails, minute insects which are troublesome to young seedlings of various kinds, is also available for publication.

*Assignment.*—F. H. Chittenden, C. H. Popenoe, T. H. Jones.

*Proposed expenditures, 1918-19.*—\$2,100.

#### INVESTIGATIONS OF INSECTS ATTACKING GREENHOUSE VEGETABLES.

##### Insects Attacking Greenhouse Vegetables:

*Object.*—To effect the control of several species of injurious insects affecting greenhouse truck crops as grown commercially in this country.

*Procedure.*—Methods adopted for the investigation of other injurious pests will be followed, including the study of the effects of fumigants and other



insecticides in connection with various greenhouse temperatures and moisture conditions.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—A publication on greenhouse fumigation under commercial conditions is under way. Data on a number of the more serious greenhouse pests have been collected, and additional practical publications will soon be completed.

*Assignment.*—F. H. Chittenden, C. H. Popenoe.

*Proposed expenditures, 1918-19.*—\$500.

#### INSECT TRANSMISSION OF TRUCK-CROP DISEASES.

##### **Insect Transmission of Truck-Crop Diseases:**

*Object.*—To investigate the relation of insects to the transmission of a number of serious diseases affecting truck crops on a commercial scale.

*Procedure.*—Experts are assigned to localities affected by numerous truck-crop diseases difficult to control where it seems probable that insects play an important rôle in the transmission of the diseases. Careful tests are made covering the activities of the insects in disease transmission and the necessary methods for the prevention of the spread of such diseases through the restriction of the insects themselves.

*Location.*—Plymouth, Ind., Muscatine, Iowa, and Madison, Wis.

*Date begun.*—1917.

*Results.*—This work has only recently received major consideration; hence it is too early to report results.

*Assignment.*—J. E. Dudley, F. M. Wadley.

*Proposed expenditures, 1918-19.*—\$5,000.

**Total, Truck-Crop Insect Investigations, \$63,400, including \$5,640 statutory.**

(See also Supplement—Emergency Activities, p. 562.)

#### STORED-PRODUCT INSECT INVESTIGATIONS.

##### **Supervision:**

*Object.*—To plan and direct the activities relating to stored-product insect investigations, including supervision of scientific work, general office routine, correspondence, etc.

*Location.*—Washington, D. C.

*Date begun.*—1917.

*Assignment.*—E. A. Back.

*Proposed expenditures, 1918-19.*—\$5,250.

##### **Grain Insects:**

*Object.*—To determine the life histories and habits of corn, rice, and wheat weevils and various other species of insects which attack stored grain, and to develop appropriate remedies for the control of these pests.

*Procedure.*—Extensive investigations are made to determine species of troublesome weevils and the amount of injury resulting from their work. Weevils are collected and reared in the field laboratory, and observations are made on their life history, habits, etc. Laboratory observations are checked by extended observations in the field. Remedial measures are undertaken based on a knowledge of the behavior of the insect. The work will be extended to include all important species of weevils, with a view to furnish a comprehensive account of these insects as a class.

*Location.*—Southern States.

*Date begun.*—1917.

*Assignment.*—To be made later.

*Proposed expenditures, 1918-19.*—\$6,000.

##### **Bean and Pea Insects:**

*Object.*—To determine the life histories and habits of weevils attacking stored beans and peas and to investigate remedies to prevent injury.

*Procedure.*—Careful biological studies of these insects are made in the laboratory and under field conditions. Remedial investigations are carried out in storage to determine the most satisfactory time and method to kill weevils.



*Location.*—Washington, D. C.

*Date begun.*—1917.

*Probable date of completion.*—1920.

*Assignment.*—A. B. Duckett.

*Proposed expenditures, 1918-19.*—\$2,600.

#### **Cowpea and Peanut Insects:**

*Object.*—To determine the life history and habits of the cowpea weevil, peanut moth, and other insects attacking cowpeas and peanuts in storage and to determine methods for combating them.

*Procedure.*—Thorough biological studies of these insects will be made in a laboratory located in a center of production. Experiments will be conducted to test known methods of control and to devise new methods.

*Location.*—New Orleans, La.

*Date begun.*—1918.

*Probable date of completion.*—1923.

*Assignment.*—Leader to be appointed.

*Proposed expenditures, 1918-19.*—\$2,450.

#### **Mill Insects:**

*Object.*—To determine the life history and habits of the Mediterranean flour moth and other mill products and thoroughly test out remedies for their control.

*Procedure.*—Biological studies are carried on in a laboratory located in a milling district, and remedial measures are tested on a small scale. The cooperation of mill owners in the surrounding region is depended upon to furnish the means for large-scale remedial and control work.

*Cooperation.*—Flour-mill owners.

*Location.*—Indianapolis, Ind.

*Date begun.*—1917.

*Probable date of completion.*—1922.

*Assignment.*—To be made later.

*Proposed expenditures, 1918-19.*—\$5,400.

#### **Insects Affecting Drugs:**

*Object.*—To make a general survey of insects attacking drugs and to study the biology and habits of these pests.

*Procedure.*—Material will be gathered by means of travel and correspondence and studied in a laboratory specially equipped for this work. At this laboratory remedial measures will be devised and applied.

*Cooperation.*—Druggists throughout the country.

*Location.*—Washington, D. C.

*Date begun.*—1918.

*Probable date of completion.*—1923.

*Assignment.*—E. A. Back.

*Proposed expenditures, 1918-19.*—\$2,500.

#### **Insects Affecting Households:**

*Object.*—To determine the life history and habits of household insects and devise methods for their control.

*Procedure.*—A thoroughgoing laboratory study is being made of the biology and habits of the various pests to form the basis for recommendations leading to a more satisfactory control. The specialist in charge cooperates with householders in testing and in putting into practice remedial measures.

*Location.*—Orlando, Fla.

*Date begun.*—1918.

*Assignment.*—Leader to be appointed.

*Proposed expenditures, 1918-19.*—\$3,000.

#### **Investigation of Fumigants:**

*Object.*—To determine the value of various fumigants in suppressing insects affecting stored products and their effectiveness under varying conditions.

*Procedure.*—Investigational work will be conducted wherever opportunity presents itself.

*Location.*—At various points throughout the country; more especially at large grain and warehouse centers.



*Date begun.*—1918.

*Assignment.*—Leader to be appointed.

*Proposed expenditures, 1918-19.*—\$2,800.

(**Argentine Corn Weevil:** Discontinued as a separate project; included under "Grain Insects.")

(**General Stored-Product Insect Pests:** Discontinued as a separate project; work stated under other projects of this group.)

**Total, Stored-Product Insect Investigations, \$30,000.**

(See also Supplement—Emergency Activities, p. 561.)

## BEE-CULTURE INVESTIGATIONS.

### Supervision:

*Object.*—To direct and supervise the research and extension activities in connection with bee culture, to carry on clerical necessary work in connection therewith, and to conduct the correspondence of the office.

*Location.*—Washington, D. C., and the branch laboratory at Drummond, Md.

*Date begun.*—1881.

*Assignment.*—E. F. Phillips.

*Proposed expenditures, 1918-19.*—\$7,200 (research, \$2,400; extension, \$4,800.

[Research.]

### Wintering of Bees:

#### (a) REACTION TO WINTER CHANGES—

*Object.*—To determine the various methods by which bees respond to changes in external temperature and other environmental factors.

*Procedure.*—Careful records are kept of the temperature changes in the colony and hive in conjunction with records of climatic conditions surrounding them. Changes due to temperature and meteorological and other environmental factors are studied. The observations so far have dealt especially with temperature changes due to environmental factors. Special attention has been given to the actual amount of heat produced by a colony and the output of carbon dioxid.

*Location.*—Drummond, Md.

*Date begun.*—1912.

*Results.*—The reactions of the normal colony to changes in external temperature and the effects of various irritations have been determined and the results published in Department Bulletin 93. The effects of wind velocity and constancy and of changes in humidity of the air immediately surrounding the bees have been determined. A large mass of data has been obtained, which is being worked up as rapidly as possible for publication. The effect of various foods in winter has been studied with special reference to the cause of dysentery in bees.

*Assignment.*—E. F. Phillips, George S. Demuth.

*Proposed expenditures, 1918-19.*—\$500.

#### (b) CARE DURING WINTER—

*Object.*—To determine the best methods of caring for bees during winter in all sections of the United States; to determine the conditions under which bees do the least work in winter, thus conserving their vitality for spring activities.

*Procedure.*—From the records of activities of colonies in the cellar and of those packed and protected in various ways from adverse weather conditions out of doors the optimum environmental conditions are determined. Field observations are made during winter and early spring to determine the cause of any heavy losses reported in any sections and to learn under what conditions in those sections the loss did not occur. Advice to beekeepers is given by means of press notices, circulars, and in similar ways to prevent heavy winter loss. This loss usually averages over 10 per cent, but was higher in 1917-18. Ultimately this project will be merged with the extension activities of the office.

*Location.*—Drummond, Md.

*Date begun.*—1912.



*Results.*—Definite recommendations are now available for successful wintering of bees in all sections of the country. The principles of outdoor wintering are presented in Farmers' Bulletin 695, and another bulletin on wintering in the cellar will be prepared as soon as possible. Specific recommendations were prepared for distribution during the autumn of 1917 to prevent the usual losses during winter.

*Assignment.*—E. F. Phillips, George S. Demuth.

*Proposed expenditures, 1918-19.*—\$5,000.

**(Development of Bees:** Project suspended, at least for the duration of the war. Studies on the development of the larva are still incomplete, but the results of the investigation of the development of the bee in the egg have been published in book form.)

**(Effects on Bees of Spraying Fruit Trees:** Project suspended. In 1914 orchards in full bloom were purposely sprayed to determine how bees are affected by arsenical insecticides. In 1915 and 1916 observations were made under conditions of commercial spraying, and in 1917 a few apple trees were sprayed at a time when the number of bees present was unusually large. The results of all these experiments have been tabulated and prepared for publication, except a part of the 1917 work. The project may be said to be completed unless in the final formulation of results it may appear desirable to repeat certain minor details.)

### Diseases of Bees:

*Object.*—To study the symptoms, causes, geographical distribution, and method of control and treatment of the diseases of bees, both larva and adult.

*Procedure.*—Suspected material from various localities is examined and diagnosed, and healthy colonies are inoculated with various micro-organisms. Cooperation is maintained with apiary inspectors in the various States to perfect control measures. Suspected samples are diagnosed for beekeepers, thus preventing errors due to the application of the wrong treatment. A special study is being made of diseases of adult bees.

*Location.*—Drummond, Md.

*Date begun.*—1907.

*Results.*—The causes of the three diseases of bee larvæ have been determined and methods of treatment simplified and perfected. The distribution of these diseases in the United States is known, thus enabling the apiary inspectors to plan their work economically. The symptoms and treatment have been published. During the year a Farmers' Bulletin on the control of European foulbrood was prepared.

*Assignment.*—Arnold P. Sturtevant.

*Proposed expenditures, 1918-19.*—\$2,200.

[Extension.]

### Demonstration Work in Beekeeping:

*Object.*—To conduct meetings and demonstrations and to provide instruction in beekeeping through and in cooperation with the county agricultural agents of the various States in which work is conducted and to make immediately available information obtained as a result of the research activities of the office as well as from a study of practical manipulations and methods employed by progressive commercial beekeepers.

*Procedure.*—A specialist in beekeeping is appointed, in cooperation with the Office of Extension Work in the South, States Relations Service, for general work in the 15 Southern States. Specialists are also appointed, in cooperation with the extension divisions of North Carolina, New York, Oklahoma, and Mississippi, for more intensive work in these States. Five other specialists are appointed for work in groups of States. These specialists cooperate with the regular extension organization, and a special effort is being made to train county agents in beekeeping, so that they can assist beekeepers in their counties. During 1918 specially prepared circulars are being distributed to beekeepers throughout the country, particularly in those States not covered by the specialists, urging an increase in the production of honey and presenting



briefly the best methods of obtaining maximum yields per colony and of preventing loss from poor wintering, diseases, and especially from excessive swarming.

*Cooperation.*—States Relations Service and the extension divisions of agricultural colleges in 30 States.

*Date begun.*—1916.

*Results.*—A good organization of the beekeepers of North Carolina has been formed, as well as some 30 county associations of beekeepers in various other States. Much interest is being manifested by beekeepers throughout the country, and a large number of beekeepers in the Southern States are transferring their bees from box hives and logs to modern hives.

In addition to the extension activities, the beekeepers of the country have been greatly encouraged in their work by the aid received from various Government offices. The Food Administration has rendered considerable help by granting permits to beekeepers to purchase sugar at the time of the sugar shortage. The Food Administration, as well as the Bureau of Markets of this department, has aided beekeepers and dealers in supplies by expediting shipments delayed by embargoes. Through the information available from the market news service of the Bureau of Markets beekeepers have been able to get a better price for their honey, and this has greatly encouraged them to increase production to the maximum. While the losses of the winter 1917-18 were rather heavy, every effort is being made to supply beekeepers with bees from the Southern States, and it is anticipated that the honey crop for 1918 will be the largest on record.

*Assignment.*—E. F. Phillips, G. H. Cale, E. L. Sechrist, C. L. Sams, E. F. Atwater, E. W. Atkins, Ward H. Foster, C. H. Stiles, R. B. Willson, E. G. Baldwin, Geo. H. Rea, D. A. Davis.

*Proposed expenditures, 1918-19.*—\$21,300.

**Total, Bee-Culture Investigations,** \$36,200, including \$1,200 statutory (research, \$10,100; extension, \$26,100).

(See also Supplement—Emergency Activities, p. 563.)

[Research.]

## TROPICAL AND SUBTROPICAL FRUIT INSECT INVESTIGATIONS.

### Supervision:

*Object.*—General direction and supervision of investigations and routine laboratory and clerical work.

*Location.*—Washington, D. C.

*Date begun.*—1907.

*Assignment.*—C. L. Marlatt.

*Proposed expenditures, 1918-19.*—\$5,160.

### Citrus-Fruit Insect Investigations in California:

*Object.*—To investigate the injurious insects of subtropical fruits of southern California, particularly the orange, including such continuation as may be necessary of experimental work in the fumigation of citrus groves with hydrocyanic-acid gas; to study other means of control of citrus insects and means of control of insects affecting the olive, guava, and other subtropical cultures; and to investigate the life history and habits of all these insects as a basis for control operations.

*Procedure.*—Direct experimental control operations, in cooperation with grove owners, and field and laboratory studies of the insects involved; special studies of insecticides and other means of control. To secure the benefits of the information already accumulated, educational and extension work will be undertaken whenever feasible in cooperation with the States Relations Service of this department.

*Cooperation.*—County horticultural commissioners, Bureau of Chemistry, and States Relations Service.

*Location.*—Headquarters, Alhambra, Cal.; citrus belts of southern California.

*Date begun.*—1907.

*Results.*—(1) During 1918: The experimental and orchard work in relation to the citrus mealy bug has developed valuable means of control,



and Farmers' Bulletin 862, "The Common Mealy Bug and Its Control in California," was published. The relationship of the Argentine ant to various citrus scale insects in California is given in Farmers' Bulletin 928, "Control of the Argentine Ant in Orange Groves." Additional experimental work looking to the control of the Argentine ant in the citrus groves of California is now well under way.

(2) Prior to 1918: Standardization of the hydrocyanic-acid gas treatment of citrus trees in groves; fumigation placed on an accurate scientific and commercial basis, greatly increasing its efficiency; thorough investigation of the various mealy bugs infesting citrus trees, including laboratory studies and testing remedies on a commercial or practical field basis.

*Assignment.*—R. S. Woglum.

*Proposed expenditures, 1918-19.*—\$6,000.

### **Citrus-Fruit Insect Investigations in Florida:**

*Object.*—To test on a commercial basis the practicability of control measures for the white fly and scale insects, recommended as the result of investigations of previous years; also to investigate the biology, injury, and methods of control of the rust mite and any new and injurious insects affecting citrus trees in Florida.

*Procedure.*—Suitable groves in various sections of the State are selected and sprayed in accordance with methods which early experimental work has shown to be most promising. Life-history studies and methods of control are investigated in the laboratory and in the field. Incidentally other insects affecting tropical and subtropical fruit trees are given consideration.

*Cooperation.*—Florida Experiment Station and local grove owners.

*Location.*—Headquarters, Orlando, Fla., with experimental demonstrations throughout the State.

*Date begun.*—1907.

*Results.*—(1) During 1918: Further demonstration of the practicability of control of the citrus white fly, at normal cost, by the use of sprays recommended; demonstration of sulphur control of the rust mite, correcting the injuries from this pest known as "russety fruit," "shark skin," "silver scurf," and "buckskin"; demonstration of these results in some thirty groves treated in cooperation with and, except for supervision, at the expense of the owners. Publications issued: Department Bulletin 645, "Some Reasons for Spraying to Control Insect and Mite Enemies of Citrus Trees in Florida," and Farmers' Bulletin 933, "Spraying for the Control of Insects and Mites Attacking Citrus Trees in Florida."

(2) Prior to 1918: Satisfactory methods of control of the white fly perfected the life history of the insect determined, and the predacious and parasitic insects studied. Results reported in the following publications of the Bureau of Entomology: Bulletin 76, "Fumigation for the Citrus White Fly"; Circular 168, "Spraying for White Flies in Florida"; Bulletin 102, "Natural Control of White Flies in Florida"; Circular 111, "Preparations for Winter Fumigation for the Citrus White Fly"; Bulletin 92, "White Flies Injurious to Citrus in Florida"; also in Journal of Agricultural Research, vol. 2, No. 6, "Papaya Fruit Fly"; and Economic Entomology, vol. 8, No. 2, "Spraying Scheme for the Control of Insect Pests on Citrus Trees in Florida."

*Assignment.*—W. W. Yothers.

*Proposed expenditures, 1918-19.*—\$4,000.

**(Investigation of the Argentine Ant in Relation to Citrus Fruits:** Discontinued as a separate project; further work to be conducted under "Citrus-Fruit Insect Investigations in California" and "Citrus-Fruit Insect Investigations in Florida." Farmers' Bulletin 928, "Control of the Argentine Ant in Orange Groves," has been issued. Department Bulletin 647, "The Argentine Ant in Relation to Citrus Groves," is in press.)

### **Investigations of Insects Affecting Tropical and Subtropical Fruits and Plants in Greenhouses:**

*Object.*—To perfect economical and effective commercial methods of controlling insects affecting tropical and subtropical fruits and plants in greenhouses. Life-history studies will be undertaken when necessary.

*Procedure.*—Suitable greenhouses are selected for testing the principal means of control, namely, fumigation and arsenical and other sprays.



*Cooperation.*—Federal Horticultural Board, Bureau of Plant Industry, Bureau of Chemistry, and local florists.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—Greenhouse fumigation with hydrocyanic-acid gas has been placed on a commercial basis, and two bulletins have been published on the use of this fumigant to control greenhouse insects on ornamental plants. A bulletin is now in course of preparation on the rose midge, and life-history studies of the chrysanthemum aphid and chrysanthemum midge are well advanced. Considerable data have been assembled on the effect of insecticides on various greenhouse plants and insects infesting them.

*Assignment.*—E. R. Sasser.

*Proposed expenditures, 1918-19.*—\$2,500.

### **Fluted Scale Investigations in Louisiana:**

*Object.*—To propagate and disseminate the predacious and parasitic enemies of the fluted scale with a view to control the latter, which has recently become a serious pest to ornamental and subtropical plants in and about New Orleans.

*Procedure.*—The Australian ladybird and a dipterous parasite [*Cryptochætum* (*Lestophonus*) *iceryæ* Will.] are introduced into Louisiana from Florida and California and are reared in suitable breeding cages and at the proper season colonized in districts where the fluted scale has gained a foothold.

*Cooperation.*—City of New Orleans, Conservation Commission of Louisiana, and Louisiana Experiment Station.

*Location.*—New Orleans, La.

*Date begun.*—1917.

*Results.*—The fluted scale in and near New Orleans is now well under control.

*Probable date of completion.*—1919.

*Assignment.*—E. R. Barber.

*Proposed expenditures, 1918-19.*—\$2,000.

### **Insects Affecting the Date Palm:**

*Object.*—To study the life history of the two principal date-palm scale insects with a view to determine methods of control.

*Procedure.*—Suitable infestations are located and life-history studies, both in field and laboratory, undertaken.

*Cooperation.*—County horticultural commissioners and California Experiment Station.

*Location.*—Indio, Cal., with such investigations in Arizona and Texas as may be necessary.

*Date begun.*—1913; discontinued in 1915 and again taken up in 1917.

*Results.*—Life history of the Blanchard scale practically completed.

*Assignment.*—A. D. Borden.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

### **Investigations of Insects Affecting Mango, Guava, Avocado, and Other Subtropical Fruits:**

*Object.*—To study the life history, habits, and means of control of fruit fly and other insect enemies of avocado, mango, guava, papaya, and other tropical and subtropical fruits which are being commercially developed, particularly in southern Florida, and to meet the needs of the inspection and safeguarding of plants grown in the introduction gardens at Miami. On account of the proximity to southern Florida of Cuba and the Bahamas, and the existing traffic facilities, this region is especially open to invasion by important fruit pests of these contiguous islands, and a number of serious insect enemies of Florida fruit have already gained entrance from these nearby sources. The maintenance of this project will assist in safeguarding against further introductions of such injurious insects from the sources named.

*Procedure.*—Suitable infestations are located and life-history studies and the development of remedial measures undertaken.



*Cooperation.*—Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry, Federal Horticultural Board, and individuals and associations.

*Location.*—Headquarters, Miami, Fla.

*Date begun.*—1917.

*Results.*—Life-history studies and remedial work well advanced. The presence of several recently imported insects has been established, and an effort, in cooperation with Florida State Plant Board, has been made to control and eliminate these pests.

*Assignment.*—G. F. Moznette.

*Proposed expenditures, 1918-19.*—\$2,000.

**(Investigations of Miscellaneous Tropical and Subtropical Fruit Insects:**  
Discontinued as a separate project; work stated under other projects of this group.)

**Total, Tropical and Subtropical Fruit Insect Investigations,** \$21,660, including \$5,160 statutory.

(See also Supplement—Emergency Activities, p. 563.)

## INVESTIGATION AND CONTROL OF THE MEDITERRANEAN AND OTHER FRUIT FLIES.

### Supervision:

*Object.*—General direction and supervision of the various projects and the conduct of the administrative office, in cooperation with the Federal Horticultural Board.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Assignment.*—C. L. Marlatt.

*Proposed expenditures, 1918-19.*—\$5,000 (research, \$2,000; regulation, \$3,000).

[Regulation.]

### Control of Export Hawaiian Fruit:

*Object.*—The general enforcement of Quarantine No. 13 on account of the Mediterranean fruit fly and the melon fly, including inspection and certification of pineapples, bananas, and other fruit for export from Hawaii to the mainland of the United States.

*Procedure.*—Enforcement of the prohibitory features of the quarantine by inspection of exports from Hawaii and by warnings and notifications to common carriers and their agents and to shippers and all passengers on vessels plying between Hawaii and the United States, supplemented by further inspection at mainland ports of arrival, in cooperation with the State horticultural authorities; inspection and certification of Hawaiian pineapples, bananas, and other fruit, export of which is permitted to the United States.

*Cooperation.*—Federal Horticultural Board, Hawaiian Territorial Board of Agriculture, State inspectors, and United States postal service and customs service.

*Location.*—Honolulu, Hawaii, San Francisco, Cal., and other Pacific ports.

*Date begun.*—1912.

*Results.*—Effective enforcement of the regulations governing the movement of pineapples, bananas, and other fruit, export of which is permitted; enforcement of the prohibition of the movement to the mainland of other host fruits of the Mediterranean fruit fly and the melon fly.

*Assignment.*—C. E. Pemberton, H. F. Willard.

*Proposed expenditures, 1918-19.*—\$8,000.

### Control of Foreign Fruit Offered for Entry:

*Object.*—Inspection and regulation of the entry of fruit imported into the United States from Mediterranean and other countries in which the fruit flies are known to occur.

*Procedure.*—Fruits likely to be infested with the fruit flies are inspected at various ports of entry.

*Cooperation.*—Federal Horticultural Board, United States postal service and customs service, State inspectors, and inspection services of foreign countries.

*Location.*—Washington, D. C., and ports of entry.



*Date begun.*—1912.

*Results.*—Efficient inspection is being maintained at ports of entry where importations of dangerous fruit flies may be expected, notably Pacific ports; a prohibitory quarantine maintained against citrus fruit of Mexican origin.

*Assignment.*—E. R. Sasscer, Harold Morrison.

*Proposed expenditures, 1918-19.*—\$2,000.

[Research.]

### Investigations of Foreign Fruit Offered for Entry:

*Object.*—Investigations of fruits imported into the United States from Mediterranean or other countries in which fruit flies are known to occur, as a basis for any necessary quarantine action.

*Procedure.*—Inspection at port of entry or at destination of fruit imported from foreign countries in which the fruit flies are known to occur.

*Cooperation.*—Federal Horticultural Board and State quarantine officers.

*Location.*—Washington, D. C., and various ports of entry.

*Date begun.*—1912.

*Results.*—Results of importance for action of the Federal Horticultural Board obtained relative to the lemon and other citrus fruits from Mediterranean countries, tomatoes, potatoes, and figs and other fruits from the same region, and fruits likely to be imported from Bermuda and the West Indies; similar results obtained relative to Mexican fruits and fruits of trans-Pacific origin. This investigation is a continuing one and must be kept up each year, covering substantially the same ground.

*Assignment.*—C. L. Marlatt.

*Proposed expenditures, 1918-19.*—\$2,000.

### Life-History and Natural-Enemy Studies:

*Object.*—To study the life history of the Mediterranean and other fruit flies and the control of these pests through the introduction and distribution of their natural enemies.

*Procedure.*—Life-history studies of various fruit flies are undertaken under varying climatic conditions, and natural enemies are introduced, distributed, and observed under field conditions.

*Cooperation.*—Federal Horticultural Board, Hawaiian Territorial Board of Agriculture, and officials and experts of foreign countries.

*Location.*—Honolulu, Hawaii.

*Date begun.*—1912.

*Results.*—The following papers covering results of this investigation have been published in the Journal of Agricultural Research as follows: "Life History of the Melon Fly," vol. 3, No. 3; "Susceptibility of Citrus Fruits to the Attack of the Mediterranean Fruit Fly," vol. 3, No. 4; "Life History of the Mediterranean Fruit Fly from the Standpoint of Parasite Introduction," vol. 3, No. 4; "Banana as a Host Fruit of the Mediterranean Fruit Fly," vol. 5, No. 17; "Effect of Cold-Storage Temperatures upon the Pupæ of the Mediterranean Fruit Fly," vol. 6, No. 7; "Effect of Cold-Storage Temperatures upon the Mediterranean Fruit Fly," vol. 5, No. 15; "Fruit Fly Parasitism in Hawaii during 1916," vol. 12, No. 2; and "Interrelations of Fruit Fly Parasites in Hawaii," vol. 12, No. 5; Department Bulletin 491, "The Melon Fly in Hawaii"; "Parasitism Among the Larvæ of the Mediterranean Fruit Fly in Hawaii during 1915," Reprint from Journal of Economic Entomology, vol. 9, No. 2 (1916); Department Bulletins—536, "The Mediterranean Fruit Fly in Hawaii"; 640, "The Mediterranean Fruit Fly"; and 643, "The Melon Fly"; and Yearbook article (1917), "Danger of Introducing Fruit Flies in the United States."

*Assignment.*—C. E. Pemberton, H. F. Willard.

*Proposed expenditures, 1918-19.*—\$2,000.

### Geographical Distribution of Fruit Flies:

*Object.*—To determine the geographical distribution and importance of fruit-fly enemies of imported fruits as a basis for needed quarantine or regulatory action.

*Procedure.*—Surveys are made of districts from which the United States receives imported fruit in relation to known fruit-fly enemies which it is



desirable to exclude from this country; study of these insects to determine their habits and means of exclusion with the least restriction to fruit importations.

*Cooperation.*—Federal Horticultural Board and officials and experts of foreign countries concerned.

*Location.*—Headquarters, Washington, D. C.

*Date begun.*—1916, as a separate project; continued from project "Life-History and Natural-Enemy Studies," begun in 1912.

*Results.*—A preliminary survey has been made in various West Indian islands with special reference to the danger of introducing fruit flies and other injurious tropical and subtropical fruit insects into the United States from this region.

*Assignment.*—H. Morrison, Emily S. Reed.

*Proposed expenditures, 1918-19.*—\$10,200.

### **Investigations of Fruit Flies and Other Tropical and Subtropical Fruit Insects in the Canal Zone, Panama:**

*Object.*—To study fruit flies and other tropical and subtropical fruit insects now established in the Canal Zone in order to determine the extent and character of their injury and the danger of their introduction into the United States.

*Procedure.*—A field station will be established in the Panama Canal Zone in cooperation with the authorities governing the zone. Careful attention will be given to the important insects infesting tropical and subtropical fruits as regards life history, biology, and methods of control.

*Cooperation.*—Authorities governing the Panama Canal Zone and Federal Horticultural Board.

*Location.*—Canal Zone.

*Date begun.*—1918.

*Assignment.*—H. F. Dietz.

*Proposed expenditures, 1918-19.*—\$4,000.

**Total, Investigation and Control of the Mediterranean and Other Fruit Flies, \$33,200, including \$1,200 statutory (research, \$20,200; regulation, \$13,000).**

[Research.]

## **MISCELLANEOUS INSECT INVESTIGATIONS.**

### **SUPERVISION.**

#### **Supervision:**

*Object.*—To supervise the investigations and carry on administrative and clerical work necessary for their practical conduct.

*Location.*—Washington, D. C.

*Date begun.*—1879.

*Assignment.*—L. O. Howard, W. D. Hunter, W. D. Pierce.

*Proposed expenditures, 1918-19.*—\$1,405.

### **IDENTIFICATION AND CLASSIFICATION OF INSECTS.**

#### **Identification and Classification of Insects:**

*Object.*—Identification and classification of insects, including anatomical and biological work of a general character. The work under this project forms the basis for many of the investigations of the bureau. It supplies the fundamental information necessary before field investigations can be prosecuted. It also provides a reference section for the comparison of specimens and aids State entomologists and others in the general promotion of entomology and the control of injurious species.

*Procedure.*—Competent specialists are placed in charge of the collections at the United States National Museum, who determine all material which is sent in. Practically every year some unexpected and unusual outbreak occurs, frequently of some insect which has not been carefully studied, making it necessary to conduct immediate field investigations. Such funds as are needed for this emergency investigation are, as a rule, drawn from this allotment, and the special experts of the identification-work assignment are used in such cases as far as possible.

*Cooperation.*—National Museum, which houses the collections and provides working rooms.



*Location.*—Washington, D. C.

*Date begun.*—1897.

*Results.*—Used in correspondence, in publications of the bureau, and by employees engaged in biological studies in the field.

*Assignment.*—E. A. Schwarz, H. S. Barber, C. H. T. Townsend, August Busck, A. N. Caudell, Rolla P. Currie.

*Proposed expenditures, 1918-19.*—\$28,995, including \$9,720 statutory.

#### INVESTIGATIONS OF INSECTS AFFECTING THE HEALTH OF MAN.

##### Life History and Control of Spotted Fever Tick in the Northwest:

*Object.*—To study the relationship of the tick to newly found animal hosts, especially in eastern Montana, where the disease is becoming more prevalent. Very important observations have recently been made which necessitate an entirely new review of the biology of the tick and the development of new means of control.

*Procedure.*—Careful biological studies will be made of the tick on its various hosts, with a view to find the proper methods of control. Whenever possible, arrangements will be made for large-scale experimental operations aimed at eliminating the tick from definite areas. These operations will include systematic dipping of large animal hosts, educational work, spring burning of pastures, eradication of rodent hosts, and such other methods as the biological evidence indicates advisable.

*Cooperation.*—Montana State Board of Entomology, State Entomologist of Montana, and Bureau of Biological Survey of this department.

*Location.*—Points in Montana.

*Date begun.*—1913.

*Results.*—Considerable progress has been made in the extermination of the ticks in the Bitter Root Valley, where the work was very favorably received.

*Assignment.*—F. C. Bishopp.

*Proposed expenditures, 1918-19.*—\$2,000.

##### Relation of Malaria Mosquitoes to Agriculture:

*Object.*—To prevent malaria on the farm, with special reference to the requirements of southern plantations; and to determine the measures of prevention that apply in a practical manner to farming conditions, based on methods for the protection from or the repression of the mosquitoes which convey the disease.

*Procedure.*—An intensive study is being made on a plantation in the Delta region of Louisiana in the lower Mississippi Valley, where conditions are typical as regards plantation operations, endemic malaria, and the mosquitoes that convey the disease. Comparative studies are in progress in southern Arkansas and in the Yazoo-Mississippi Delta and the hill country of the Mississippi. The work includes a determination of the manner in which malaria reduces the net profits from crops; the bionomics of the species of mosquitoes that convey the disease; determination of the species of mosquitoes concerned in the transmission of the disease; and experimental measures of control, to determine those methods that can be coordinated with the operations of a plantation on a practical basis.

*Cooperation.*—Tulane Medical School, New Orleans, La.; Mississippi Agricultural College, Agricultural College, Miss.; Bureau of Fisheries; and Office of Farm Management.

*Location.*—Mound, La., Scott, Ark., New Orleans, La., and points in Mississippi.

*Date begun.*—1913.

*Results.*—The amount of the reduction in crops in one plantation from loss of time and reduced efficiency of labor on account of malaria has been measured. The species of mosquitoes involved in the transmission of the disease in this particular region have been determined, and progress has been made in the study of their breeding requirements. The relation of rainfall and temperature to mosquito density and of mosquito density to the malaria rate is under consideration. Experimental control measures, including favorable locations for houses in respect to mosquito infestation, treatment of surface collections of water to render them unsuitable for mosquito breeding, destruction of adult mosquitoes, mechani-



cal protection from adult mosquitoes, drainage, and the use of fish that feed upon mosquitoes, are in progress.

*Assignment.*—W. V. King.

*Proposed expenditures, 1918-19.*—\$5,000.

### House-Fly Control:

*Object.*—To study the habits of the house fly with reference to control, test agents for use in destroying the immature stages in stable manure and in other substances, and study the chemotropic responses of the insect and the parasitic fauna of its body.

*Procedure.*—Life-history experiments are conducted at various places to throw light on points in the biology of the fly on which little or no information is available at this time. Special attention is given to the testing of baits for use in connection with fly traps of various kinds. The reactions of the fly to various repellents are also studied. A recent suggestion for the use of poison baits which are sprayed about stables will be tested through experiments conducted under varying conditions. The effectiveness of various types of pits or bins for destroying the insects in stable manure is receiving attention, and an effort will be made to adapt a recent discovery involving the utilization of the natural heat of fermenting manure to prevent the development of flies. Further studies of the maggot trap, which has been brought to a reasonable degree of perfection as a result of the work of the project, will be conducted, and studies will be made of the parasitic enemies of the house fly.

*Cooperation.*—Bureaus of Chemistry, Plant Industry, and Animal Industry, and the Maryland Agricultural College.

*Location.*—Drummond, Bethesda, and College Park, Md., and Dallas, Tex.

*Date begun.*—1913.

*Results.*—In the recent work on the house fly all chemicals which have been regarded as effective in destroying the immature stages have been tested and their relative efficiency determined. Two substances which have not hitherto been used for this purpose have been found to be very effective, and their use has already become general as a result of the information conveyed through the publications of the department. The maggot trap offers a means of removing fly larvæ from stable manure without the application of chemicals.

*Assignment.*—F. C. Bishopp.

*Proposed expenditures, 1918-19.*—\$2,000.

### Control of Body and Head Lice:

*Object.*—To thoroughly study the life history of the human louse and ascertain the most available means of control.

*Procedure.*—Large quantities of lice will be obtained from various institutions and breeding experiments conducted. All insecticides, as well as other methods of control, on the person and on clothing, as well as in rooms, will be tested.

*Cooperation.*—Various charitable institutions of New Orleans; the War Department.

*Location.*—New Orleans, La., and Washington, D. C.

*Date begun.*—1918.

*Results.*—As fast as requests come from the War Department for tests, these are made and reported on. Several remedies have already been tested.

*Assignment.*—R. H. Hutchison.

*Proposed expenditures, 1918-19.*—\$5,000.

### Control of the House Fly and Other Insects in Establishments Operating under Federal Meat Inspection:

*Object.*—To devise plans for the control and eradication of the house fly and other insects under the special conditions existing in establishments operating under Federal meat inspection.

*Procedure.*—Various meat-packing establishments in different parts of the country are visited for the purpose of obtaining information on the species of flies giving annoyance, to determine their breeding places under the different conditions presented, and to suggest to the inspectors in charge methods of improving the situation. At Dallas and Fort Worth, Tex.,



more special investigations are conducted. These consist in the testing of different types of traps and baits and of methods of eliminating breeding places or destroying the infestations by means of chemicals and a study of the most desirable procedure in handling various packing-house waste products, such as paunch manure and contaminated water from washing floors, and of possible methods of checking fly breeding in stockyards, sales stables, and other prolific fly-breeding places in the vicinity of packing plants. The life histories and habits of the various species concerned are studied, in order to determine the most vulnerable points of attack. Experiments are also under way to determine the most effective screens for use in eliminating the several species of insects from slaughtering and packing establishments and methods of excluding flies from doorways and other passages by fans, cold-air blasts, etc.

*Cooperation.*—Bureau of Animal Industry and establishments operating under Federal meat inspection.

*Location.*—Dallas and Fort Worth, Tex., and various cities where establishments are operated under Federal inspection.

*Date begun.*—1915.

*Results.*—A very effective and cheap type of fly trap has been devised. Various phases of the question of fly trapping have been studied extensively, including baits, type of bait, pans, and other points which add materially to the effectiveness of fly-trapping operations. These findings have been placed in the hands of the inspectors in charge at all stations in the United States. A Farmers' Bulletin dealing with fly traps and their operation which will be useful to city sanitarians, dairymen, and farmers, as well as to butchers and packers, has been published. A statement treating of some of the problems involved in the control of insects under slaughterhouse conditions has also been prepared.

*Assignment.*—F. C. Bishopp and E. W. Laake, of the Bureau of Entomology, and George H. Shaw, of the Bureau of Animal Industry.

*Proposed expenditures, 1918-19.*—\$2,500.

### **Miscellaneous Insects Affecting the Health of Man:**

*Object.*—To devise means of control of various miscellaneous insects affecting the health of man. This investigation will cover emergency outbreaks of insects not covered by specific projects.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Results.*—A large cross-indexed card catalogue of the subject is maintained. A very complete tabulation of the data on insects reported from Army camps is in preparation and has already served to answer many questions of correspondents.

*Assignment.*—W. D. Pierce, F. C. Bishopp.

*Proposed expenditures, 1918-19.*—\$1,000.

**Total, Investigations of Insects Affecting the Health of Man, \$17,500.**

### **INVESTIGATIONS OF INSECTS AFFECTING THE HEALTH OF ANIMALS.**

#### **Life-History Investigations of the Cattle-Fever Tick:**

*Object.*—To obtain accurate information regarding the life history and habits of the tick which will be of value in the work of eradication now under way in the Southern States, and also to aid in the control of the pest in regions where the general plan of eradication is not at present applicable.

*Procedure.*—The host relations, distribution, and longevity of the tick in its various stages are studied. In this work a number of experimental animals are used to determine host relations and length of development periods. The possibility of various animals and birds scattering the ticks is studied under lot and pasture conditions. The effect of climatic conditions on the different stages is studied by exposing ticks in nature and by observing them in refrigerators and incubators.

*Cooperation.*—Tennessee and Louisiana experiment stations, Bureau of Animal Industry, and individual cattle owners in Texas.

*Location.*—Dallas, Victoria, and Uvalde, Tex.

*Date begun.*—1904.



*Results.*—Information has been gained which will assist in the work of eradication by dipping. An efficient system of tick destruction by means of pasture rotation has also been devised.

*Assignment.*—F. C. Bishopp, H. P. Wood.

*Proposed expenditures, 1918-19.*—\$2,000.

### **Investigations of Ticks Other than Cattle Ticks and Spotted-Fever Tick:**

*Object.*—To determine the relation of these pests to various hosts, the biology of the species, and feasible means of controlling them.

*Procedure.*—This project is divided into the following activities: Investigations of (1) the fowl tick, (2) the spinose ear tick, (3) the Lone Star tick, (4) the winter tick, (5) the Gulf coast tick, and (6) other species. The life histories, habits, host relation, and seasonal histories of each species are being worked out. In this work various host animals are infested and the development of the ticks noted, the length of the various developmental periods when not on hosts determined, and the period necessary to destroy by starvation obtained. The effect of various tickicides on different species is tested. Methods by which these injurious species are likely to be spread are also studied.

*Cooperation.*—Bureau of Animal Industry, in connection with investigations of spirochetosis of fowls in the United States.

*Location.*—Dallas, Victoria, and Uvalde, Tex., and Bitter Root Valley, Mont.

*Date begun.*—1905.

*Results.*—During the past fiscal year biological observations have been continued on several species. Previously life histories of several ticks had been thoroughly investigated and a number of bulletins published. Effective control measures against the fowl tick have been devised and the results published.

*Assignment.*—F. C. Bishopp, H. P. Wood.

*Proposed expenditures, 1918-19.*—\$1,500.

### **Stable Fly:**

*Object.*—To determine feasible methods of control by artificial and natural means of this cosmopolitan pest of animals and man.

*Procedure.*—Based upon studies of the biology and habits of this pest, investigations of methods of eliminating breeding places are to be continued. These include improved methods of disposing of straw, especially in the grain belt, either by careful stacking or by prompt spreading and turning under. Special attention will be given to severe local outbreaks, and further studies will be made of methods of protecting horses and other live stock from attacks by the use of repellents and protective coverings. Observations will be continued in localities where infectious anemia of horses occurs, in order to gain further information regarding the possible relationship of this fly to the disease. The distribution and seasonable occurrence of this fly are studied with a view to determine its possible relationship to diseases of man. Investigations will be undertaken looking to the practical control of the fly through the utilization of parasites where such parasites are already established and of their introduction into regions where they do not now occur.

*Cooperation.*—Bureau of Animal Industry, in connection with studies of the relation of the attack of this fly to acute forms of Texas fever and the relationship of the insect to infectious anemia; Hawaiian Experiment Station, in connection with the breeding and shipping parasites to that station.

*Location.*—Dallas, Tex., and points in South Dakota.

*Date begun.*—1912.

*Results.*—Investigations have shown the importance of this pest from the stock-raiser's standpoint, and as a result of biological studies certain recommendations which have resulted in the avoidance of outbreaks have been made. The work of the past season dealt largely with practical tests of control measures.

*Assignment.*—F. C. Bishopp.

*Proposed expenditures, 1918-19.*—\$500.

### **Screw Worms:**

*Object.*—To determine the various species of flies which attack animals and man, causing various types of myiasis, and the conditions favoring



such infestation; to determine the life histories, seasonal activity, and habits of these flies, and to test methods of control.

*Procedure.*—Larvæ from infested animals and man are collected and reared and the character and conditions prior to infestation studied. Experiments are conducted to determine the effect of the burial of carcasses at different depths, their treatment with chemicals, and their destruction by burning on the production of screw-worm flies, which breed in great numbers in dead animals. Tests are made of the relative effectiveness of different repellents on various species of screw-worm flies, and in other tests attractive substances are employed with a view to their possible utilization as poison baits.

*Cooperation.*—The Bureau of Animal Industry cooperates in experiments in the destruction of the larvæ in living animals, and various physicians furnish specimens of screw worms.

*Location.*—Dallas, Uvalde, and Victoria, Tex.

*Date begun.*—1914.

*Results.*—It has been determined that by so breeding range stock as to have the calves come in the winter or very early spring a considerable reduction from losses due to screw worms infesting calves and fresh cows results. The biologies of several of the species which have been found to attack living animals and of others associated with them which breed extensively in carcasses have been worked out. A publication dealing with the black blowfly, which is the cause of maggoty wool among sheep in the Southwest, has been issued, and a Farmers' Bulletin dealing with the screw worm and related species and methods of control has been prepared.

*Assignment.*—F. C. Bishopp, D. C. Parman, J. D. Mitchell.

*Proposed expenditures, 1918-19.*—\$1,750.

### Horseflies:

*Object.*—To determine feasible means of controlling the various species of horseflies, and thus reduce the annoyance to man and animals and the danger of spreading anthrax among animals and to man. By devising methods of combating horseflies in the southern portions of Louisiana and in Texas it is thought that certain extensive areas will be developed into excellent cattle-producing regions.

*Procedure.*—Investigations of the species which are playing important rôles in the transmission of disease and in worrying animals are conducted in regions where the losses are most acute, notably portions of southeast and southwest Texas, southern Louisiana, and certain valleys in Nevada and California. The biologies of various species of this group of flies are quite different and each requires separate investigations. With these studies as a basis, it is hoped to develop practical methods of control. It is necessary to consider methods of irrigation and drainage in connection with the question of repression.

*Cooperation.*—Bureau of Animal Industry and Nevada Experiment Station.

*Location.*—Dallas and Uvalde, Tex., Lake Charles, La., Topaz, Cal., and Reno and Deeth, Nev.

*Date begun.*—1914.

*Results.*—The principal species of horseflies causing losses in certain parts of the country have been determined. The biology of the species which is of greatest importance in southwest Texas has been partially worked out and methods of increasing the effectiveness of natural enemies devised. Tentative suggestions have also been made for the control of this species. A report of progress, detailing the life history of several species of horseflies, has been submitted.

*Probable date of completion.*—1925.

*Assignment.*—J. L. Webb, D. C. Parman, F. C. Bishopp.

*Proposed expenditures, 1918-19.*—\$4,000.

### Horn Fly:

*Object.*—To devise and improve methods of horn-fly control.

*Procedure.*—The life history and habits of this insect are studied, particular attention being given to an investigation of the longevity of adults and methods of hibernation. Studies are made of the value of the systematic collecting and spreading of manure on fields at dairies. Tests are under way to determine the practicability of the systematic destruc-



tion of adult flies on dairy cattle by means of sprays. Experiments are made in the utilization of manure-inhabiting insects which either destroy the immature flies directly or cause the drying out of the manure and their destruction thereby.

*Cooperation.*—Cooperative arrangements have been made with the Porto Rico Experiment Station whereby certain insects found in controlling the horn fly in the United States are shipped to Porto Rico, where the horn fly has recently been introduced.

*Location.*—Dallas and Victoria, Tex.

*Date begun.*—1914.

*Results.*—Since the introduction of the horn fly into the United States, in 1892-93, the Bureau of Entomology has kept records on the spread of the insect over the country. Investigations have also been conducted upon the life history of the insect. These investigations have been reported upon and various suggestions made for controlling the insect, including the use of splash boards on the sides of the dipping vats.

*Probable date of completion.*—1925.

*Assignment.*—F. C. Bishopp, J. D. Mitchell, H. P. Wood.

*Proposed expenditures, 1918-19.*—\$500.

### **Ox Warbles:**

*Object.*—To determine the present status of ox warbles in the United States and to investigate the life histories, habits, and seasonal histories of these species, together with improved methods of control.

*Procedure.*—The biology of the two species of common ox warbles of this country is studied on experimental animals kept under control, and field observations are made by agents of the bureau, as well as by correspondents throughout the country, on the abundance and seasonal history of these species. Through correspondence specimens are obtained from different parts of the United States to determine the distribution and relative abundance of the warbles in this country. One of the principal control measures, namely, the extraction of warbles by hand, is being tested on a number of dairy herds. The effect of arsenical dips on various stages of ox warbles is studied.

*Cooperation.*—Bureau of Animal Industry, in connection with effect on animals of the arsenical dips and other treatment employed in the destruction of the warbles. That bureau will also supply specimens obtained by inspectors at various packing houses.

*Location.*—Dallas, Uvalde, and Victoria, Tex.

*Date begun.*—1914.

*Results.*—It has been determined that the European ox warble, formerly supposed not to exist in this country to any extent, is rather widely distributed throughout the Northern States and is a pest of importance in the northwestern portion of this country. Considerable information has been gained regarding the abundance of this pest in different regions. Certain important observations on the season and methods of deposition of eggs and the methods by which young larvæ gain entrance into the body of the animal have been made.

*Assignment.*—E. W. Laake, F. C. Bishopp.

*Proposed expenditures, 1918-19.*—\$1,400.

### **Chicken Flea:**

*Object.*—To accumulate information on the life history, habits, distribution, and injuriousness of the insect and how it may be controlled.

*Procedure.*—The life-history work is conducted by means of cage experiments, using chickens, dogs, and rabbits as hosts. Various methods of treating the chicken yards and also the animals are studied.

*Location.*—Dallas and Uvalde, Tex.

*Date begun.*—1914.

*Results.*—Feasible methods for reducing the number of chicken fleas in poultry yards have been devised and two publications of the department dealing with this and other fleas injurious to man and animals issued.

*Probable date of completion.*—1920.

*Assignment.*—F. C. Bishopp, H. P. Wood, D. C. Parman.

*Proposed expenditures, 1918-19.*—\$200.



**Miscellaneous Insects Affecting Live Stock:**

*Object.*—To devise means of control of various insect pests affecting live stock, including bot flies of horses, buffalo gnats, the chicken bug of the Southwest, chicken mites, and other animal and poultry insects.

*Procedure.*—Information on various animal parasites is accumulated incidental to other work. The bot flies of horses, biting and sucking lice of domestic animals, and lice and other parasites of poultry are given special attention, both from the biologic and economic standpoints. The investigations of the bots are directed especially toward methods of control of the so-called nose fly, which is a serious pest of horses in the North-Central States.

*Location.*—Dallas, Tex., points in South Dakota, and various field laboratories of the bureau.

*Date begun.*—1912.

*Results.*—During the past two years the biology of the nose fly has been quite thoroughly investigated and preliminary work with control measures conducted. A publication dealing with this pest and the two other common horse bots has been issued. The bionomics of the chicken mite and the most important species of lice infesting poultry have been studied and effective measures of controlling these pests devised. It has been found that sodium fluoride is a specific against all forms of poultry lice upon which it has been tested. Publications dealing with lice and mites of poultry have been issued.

*Assignment.*—F. C. Bishopp, H. P. Wood.

*Proposed expenditures, 1918-19.*—\$2,300.

**Total, Investigations of Insects Affecting the Health of Animals, \$16,450, including \$2,300 statutory.**

(See also Supplement—Emergency Activities, p. 563.)

**Total, Miscellaneous Insect Investigations, \$64,350, including \$12,020 statutory.**

**GIPSY MOTH AND BROWN-TAIL MOTH INVESTIGATIONS.****SUPERVISION.****Supervision:**

*Object.*—To supervise and direct the scientific and practical activities and business affairs of the gipsy moth and brown-tail moth investigations and provide for miscellaneous office, laboratory, and storehouse expenses, general supplies, and fixed charges which can not be readily prorated against specific projects.

*Cooperation.*—Federal Horticultural Board, Forest Service, and various State entomologists, foresters, and nursery inspectors.

*Location.*—Principal offices, laboratory, and storehouse, Melrose Highlands, Mass.; field storehouse, Franklin, N. H.; quarantine and inspection office, Boston, Mass. The infested territory covers about one-third the area of New England; isolated colonies have occurred also in New York and Ohio.

*Date begun.*—1906.

*Assignment.*—A. F. Burgess.

*Proposed expenditures, 1918-19.*—\$17,710, including \$9,710 statutory (research, \$14,870; regulation, \$2,840).

[Research.]

**LABORATORY AND FIELD INVESTIGATIONS.****Insects Parasitic on Moths:**

*Object.*—To study the habits and life histories of the imported parasites and natural enemies of the gipsy and brown-tail moths; to determine the extent to which these parasites are increasing under field conditions in this country and ascertain their values as enemies of the insects concerned; also to collect and colonize the beneficial species in areas where they do not now exist in the infested territory.



*Procedure.*—Parasites and natural enemies of the gipsy moth and brown-tail moth have been introduced into New England from European countries and Japan. Colonies have been liberated in the worst infested areas in the field, and collections are made from year to year in order to determine the increase or decrease of the parasites and their hosts, and also for the purpose of securing material for liberating colonies in parts of the infested region where these beneficial species do not exist. In connection with this work it is necessary to study carefully the life histories and habits of the natural enemies concerned, in order that the work may be carried on intelligently. The interrelations between the parasites and their hosts, as well as factors in this country which may be responsible for decrease in parasitism, must also be carefully investigated.

*Cooperation.*—State experiment stations, entomologists, and moth superintendents in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

*Location.*—Melrose Highlands, Mass., and a large number of localities in the New England States where parasitic material has been liberated.

*Date begun.*—1906.

*Results.*—Information has been disseminated as to the character and habits of the parasites imported and their value in moth control.

*Assignment.*—S. S. Crossman.

*Proposed expenditures, 1918-19.*—\$35,000.

### **Natural Increase of the Gipsy Moth under Field Conditions:**

*Object.*—To determine the natural increase of the gipsy moth under field conditions and the relation of food plants, natural enemies, etc., to the control of this insect.

*Procedure.*—Studies are being made in about 200 selected infested areas in order to determine the natural increase of the gipsy moth under field conditions. Selections are made in different types of woodland in places where parasites have been introduced to check against other localities where none existed. The effect of defoliation on tree growths is carefully noted and definite records kept from year to year on the increase or decrease of the moth under field conditions.

*Location.*—Maine, New Hampshire, and Massachusetts.

*Date begun.*—1911.

*Results.*—Several relations of natural enemies to moth increase have been determined.

*Probable date of completion.*—1919.

*Assignment.*—C. W. Minott.

*Proposed expenditures, 1918-19.*—\$6,000.

### **Habits of the Gipsy Moth and Brown-Tail Moth:**

*Object.*—To study the habits of these insects, both in the adult and larval stages, including feeding habits of the larvæ, in order to determine whether more satisfactory and economical means of control can be devised.

*Procedure.*—Laboratory and field work will be carried on and detailed information secured concerning the reaction of these insects to sex attraction, light, food plants, and other phenomena.

*Location.*—Melrose Highlands, Mass.

*Date begun.*—1912.

*Results.*—The relation of food plants to the increase of the gipsy moth has been partially determined and a report covering most of the experiments published.

*Assignment.*—A. F. Burgess, F. H. Mosher.

*Proposed expenditures, 1918-19.*—\$10,000.

### **Relation of Wilt to Gipsy-Moth Control:**

*Object.*—To determine the identity of the disease known as the "wilt" and other diseases which affect the gipsy moth, and to investigate their relation and effect on the increase of the moth.

*Procedure.*—Technical laboratory studies are carried on to determine the identity of the organisms. Field observations to determine the relation of temperature and humidity to the prevalence and increase of these diseases are also undertaken during the summer.



*Cooperation.*—Bussey Institution of Harvard University.

*Location.*—Melrose Highlands and Forest Hills, Mass.

*Date begun.*—1912.

*Results.*—Information has been secured on the dissemination of these diseases; also much information as to their identity.

*Assignment.*—R. W. Glaser, A. W. Young.

*Proposed expenditures, 1918-19.*—\$8,300.

### Secondary Insects:

*Object.*—To determine the effect of secondary insects on trees that have been defoliated by the gipsy moth.

*Procedure.*—This work is conducted principally through field observations, which are made as opportunity permits in the infested area. Records of injury to trees are collected, a considerable amount of data secured in the field, and a few laboratory experiments on the life histories of secondary insects carried out.

*Location.*—Selected areas in Maine, New Hampshire, and Massachusetts.

*Date begun.*—1913.

*Results.*—The relation of secondary insects to the death of defoliated trees has been partially determined.

*Assignment.*—H. A. Preston.

*Proposed expenditures, 1918-19.*—\$200.

### Dispersion of Gipsy Moth:

*Object.*—To determine the means by which the gipsy moth spreads to new territory.

*Procedure.*—The information in regard to the dispersion of the gipsy moth is secured principally by using large screens coated with "tanglefoot," upon which are caught small caterpillars of the gipsy moth that are transported by the wind.

*Location.*—Selected areas in Maine, New Hampshire, and Massachusetts.

*Date begun.*—1911.

*Results.*—The relation of air currents to the dispersion of gipsy-moth caterpillars has been partially determined and preliminary results published.

*Assignment.*—C. W. Collins.

*Proposed expenditures, 1918-19.*—\$4,000.

### Introduction of Natural Enemies:

*Object.*—To carry on such work in foreign countries as may be necessary to secure natural enemies or information on parasites and diseases of the brown-tail and gipsy moths.

*Procedure.*—Arrangements are made, when possible, to secure collections of certain parasites of the gipsy and brown-tail moths. Such parasites have been received only in small numbers so far.

*Cooperation.*—Entomologists in foreign countries.

*Date begun.*—1906.

*Results.*—About 30 species of parasites and natural enemies have been introduced, and of these 7 species are increasing and assisting in controlling the gipsy moth and the brown-tail moth.

*Assignment.*—A. F. Burgess.

*Proposed expenditures, 1918-19.*—\$3,520.

### Testing Insecticides and Material for Banding Trees:

*Object.*—To test new insecticides and methods of spraying or banding trees in order to enable control work to be carried on more efficiently and economically.

*Procedure.*—New insecticides will be given field and laboratory tests for the purpose of determining whether the use of any of them is feasible.

*Location.*—Melrose Highlands, Mass.

*Date begun.*—1914.

*Assignment.*—A. F. Burgess, C. E. Hood.

*Proposed expenditures, 1918-19.*—\$2,000.

### Relation of Fungous Diseases to Gipsy and Brown-Tail Moth Control:

*Object.*—To study the effect of fungous diseases on the gipsy moth and the brown-tail moth, including a study of the diseases affecting the eggs of the gipsy-moth; to determine whether the fungous disease of the gipsy-



moth caterpillar, which was introduced from Japan several years ago, has become established in New England; and to determine the effect of fungous diseases in controlling the brown-tail moth.

*Procedure.*—Studies of the diseases mentioned are conducted in the laboratory and observations and collections made in the field to determine the benefit resulting from their use in combating the moths.

*Cooperation.*—Bureau of Plant Industry.

*Location.*—Melrose Highlands, Mass.

*Date begun.*—1916.

*Assignment.*—J. N. Summers, A. T. Speare.

*Proposed expenditures, 1918-19.*—\$2,500.

#### **Relation of Silviculture to Gipsy-Moth Control:**

*Object.*—To determine the relation of silvicultural conditions to gipsy-moth infestation, and to demonstrate the best methods of handling forest growth so as to render it unfavorable to gipsy-moth attack; to determine the most profitable utilization of products cut.

*Procedure.*—In order to carry on this work sample plots have been selected and thinned to different percentages of favored and unfavored food.

*Cooperation.*—Forest Service, State foresters, entomologists, and moth superintendents in the infested territory.

*Location.*—Selected wood lots in the infested territory in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

*Date begun.*—1913.

*Results.*—Experiments have not been conducted for a sufficient length of time to show permanent results.

*Assignment.*—G. E. Clements.

*Proposed expenditures, 1918-19.*—\$2,000.

**Total, Laboratory and Field Investigations, \$73,520, including \$3,520 statutory.**

[Research.]

#### **SCOUTING AND EXTERMINATION WORK.**

##### **Scouting and Extermination Work:**

*Object.*—To determine the area infested by the gipsy moth and the brown-tail moth, for the purpose of preventing the spread of these insects, and to apply exterminative measures in the territory where the best results can be secured in suppressing these pests.

*Procedure.*—Careful examinations are made by trained men of the towns immediately outside the area known to be infested by the gipsy moth in order to determine the spread of this insect. In the region from Lake Winnepesaukee to Long Island Sound the towns along the infested border are carefully treated each year in order to hold back the spread of infestation as much as possible. Careful examinations are made of isolated colonies outside the solid infested areas in New England, and treatment is applied whenever the States concerned are unable to bear the expense of all the work.

*Cooperation.*—State entomologists, foresters, and moth superintendents in the States concerned.

*Location.*—New England, New York, and Ohio.

*Results.*—The spread of the gipsy moth is determined annually, and many infestations in the outside territory have been exterminated.

*Assignment.*—L. H. Worthley.

*Proposed expenditures, 1918-19.*—\$179,290, including \$3,240 statutory.

[Regulation.]

#### **QUARANTINE AND INSPECTION OF NURSERY, FOREST, AND QUARRY PRODUCTS.**

##### **Quarantine and Inspection of Nursery, Forest, and Quarry Products:**

*Object.*—To provide for the inspection of plants and forest and quarry products, in order to prevent the dissemination of the gipsy moth and the brown-tail moth from infested areas.



*Procedure.*—All products mentioned in the project title are inspected by competent assistants and certified to be free from gipsy moth and brown-tail moth infestation before they are allowed to be moved to points outside the infested area.

*Cooperation.*—Federal Horticultural Board and State entomologists and inspectors in the infested territory.

*Location.*—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

*Date begun.*—1912.

*Results.*—This work has resulted in preventing the spread of gipsy moth and brown-tail moth in many localities outside the present infested area.

*Assignment.*—D. M. Rogers.

*Proposed expenditures, 1918-19.*—\$51,200, including \$1,200 statutory.

**Total Gipsy Moth and Brown-Tail Moth Investigations, \$321,720, including \$17,670 statutory (research, \$267,680; regulation, \$54,040).**



## BUREAU OF BIOLOGICAL SURVEY.

### GENERAL ADMINISTRATION.

#### Office of Chief:

*Object.*—General supervision of the business, regulatory, and research activities of the bureau.

*Cooperation.*—Other Federal departments, bureaus, boards, and commissions.

*Location.*—Washington, D. C.

*Date begun.*—1885.

*Assignment.*—E. W. Nelson, chief; W. C. Henderson, assistant chief.

*Proposed expenditures, 1918-19.*—\$16,700.

#### Office of Chief Clerk:

*Object.*—General supervision of the clerical, messenger, and char force of the bureau; work pertaining to the fiscal affairs, the central property and file rooms, handling mail, matters relating to leave of absence, and changes affecting the personnel.

*Location.*—Washington, D. C.

*Date begun.*—1911.

*Assignment.*—E. J. Thompson.

*Proposed expenditures, 1918-19.*—\$23,990.

**Total, General Administration, \$40,690, including \$29,930 statutory (regulation, \$36,215; research, \$4,400; extension, \$75).**

### GAME PRESERVATION.

#### ENFORCEMENT OF THE LACEY ACT.

#### Supervision:

*Object.*—The organization and conduct of the activities of this group of projects, including correspondence, information files, and relations to other organizations.

*Cooperation.*—Solicitor's office and Bureau of Animal Industry of this department, Department of Justice, Customs Service of the Treasury Department, State game officials, and organizations and individuals interested in the protection and conservation of wild life.

*Location.*—Washington, D. C.

*Date begun.*—1900.

*Assignment.*—W. F. Bancroft.

*Proposed expenditures, 1918-19.*—\$3,400 (regulation, \$3,100; research, \$300).

[Regulation.]

#### Interstate Commerce in Game:

*Object.*—The enforcement of sections 242, 243, and 244 of the Criminal Code of the United States regulating interstate shipment of game.

*Procedure.*—Field investigations are made of interstate traffic in game killed or shipped in violation of State laws. Evidence of violation is secured from individuals, dealers, and transportation companies and submitted to the Solicitor's office for transmission to the Department of Justice and to State game officials.

*Cooperation.*—Solicitor's office of this department, Department of Justice, State game officials, transportation companies and organizations, and individuals interested in the conservation of wild life.

*Location.*—Throughout the United States, but mainly in Arkansas, Indiana, Illinois, Kansas, Maryland, Maine, Missouri, Montana, Massachusetts,



New Hampshire, New Jersey, New York, North Dakota, Pennsylvania, South Dakota, Tennessee, and Washington.

*Date begun.*—1900.

*Results.*—Through the activities of inspectors 28 cases were reported to the Solicitor's office during the first nine months of the fiscal year 1918. Through special work in Chicago the prosecution of offenders for violating section 244 has resulted in the practical discontinuance of illegal traffic in game in that city. Work under this project as conducted during the past three years is reducing to a minimum the illegal shipment of wild game throughout the United States.

*Assignment.*—George A. Lawyer.

*Proposed expenditures, 1918-19.*—\$16,680.

### **Importation of Foreign Birds and Mammals:**

*Object.*—To prevent the introduction from foreign countries of injurious species of birds and mammals.

*Procedure.*—Six experienced scientific men are employed at the principal ports of entry to make inspections of shipments of imported birds and mammals, to identify the species in such shipments, and to determine whether any of them are prohibited from entry under section 241 of the Criminal Code of the United States.

*Cooperation.*—Customs Service, Treasury Department.

*Location.*—Washington, D. C., New York, Philadelphia, San Francisco, Honolulu, and other ports when necessary.

*Date begun.*—1900.

*Results.*—Prevention of the admission of species of birds and mammals which might become destructive pests—for example, the mongoose.

*Assignment.*—T. S. Palmer.

*Proposed expenditures, 1918-19.*—\$1,700.

### **Inspection and Quarantine of Quail:**

*Object.*—To prevent the introduction of quail disease from northern Mexico among game birds in the United States.

*Procedure.*—A quarantine and inspection service is maintained over all shipments of quail from Mexico during the season when such importations are permitted.

*Cooperation.*—Bureau of Animal Industry, and Customs Service, Treasury Department.

*Location.*—New York City, and Eagle Pass and Laredo, Tex.

*Date begun.*—1914.

*Results.*—The same regulations governed the importation of quail from northern Mexico as in 1917-18; but the season for admitting birds was changed to a later period—February 15 to April 10, inclusive. Permits were issued for the entrance of 9,500 quail into the United States through the quarantine stations at Eagle Pass and Laredo, Tex., during the 1918 season. No symptoms of quail disease were discovered in any quail brought in through Eagle Pass, and comparatively few birds entering through this port died from any cause up to the time they were shipped north.

*Assignment.*—T. S. Palmer.

*Proposed expenditures, 1918-19.*—\$700.

[Research.]

### **Publication of Information Concerning Game Laws:**

*Object.*—Compilation, publication, and distribution of information concerning game, game laws, interstate commerce in game, and importation of foreign birds.

*Procedure.*—Copies of all State and Federal game laws enacted and all bills introduced affecting game matters in general are secured, and court decisions bearing upon game legislation are compiled. In addition, periodical and other publications are searched for data on game and game laws.

*Cooperation.*—State game officials and individuals interested in game conservation.

*Location.*—Washington, D. C.

*Date begun.*—1900.

*Results.*—The annual summary of the game laws, two posters, and a directory of game officials were issued at the beginning of the hunting season.

*Assignment.*—George A. Lawyer, Frank L. Earnshaw.

*Proposed expenditures, 1918-19.*—\$1,820.

**Total, Enforcement of the Lacey Act, \$24,300, including \$2,300 statutory (regulation, \$22,180; research, \$2,120).**

#### ESTABLISHMENT AND MAINTENANCE OF MAMMAL AND BIRD RESERVATIONS.

##### Supervision:

*Object.*—The organization and conduct of the activities of this project group, including correspondence, information files, and relations to other organizations in allied work.

*Cooperation.*—National Association of Audubon Societies and State officials and individuals interested in the protection and conservation of wild life.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—George W. Field.

*Proposed expenditures, 1918-19.*—\$6,765 (regulation, \$6,365; extension, \$400).

[Regulation.]

##### General Maintenance of Reservations and Refuges:

*Object.*—To preserve and perpetuate the bird life and game mammals of the country for the benefit of the public, both from an economic and recreational standpoint.

*Procedure.*—Inspection and warden service is maintained and general supervision exercised over the bird and mammal preserves or reservations in charge of the Department of Agriculture.

*Cooperation.*—Forest Service, War Department, Navy Department, Reclamation Service, United States Coast Guard, Bureau of Fisheries, National Association of Audubon Societies, American Bison Society, Boone and Crockett Club, American Game Protective Association, State game officials, and individuals.

*Location.*—At reservations in 20 States, Alaska, Hawaii, and Porto Rico.

*Date begun.*—1909.

*Results.*—(1) Prior to 1918: Birds and game have been established, maintained, and protected on 74 national reservations. Five of these reservations, including the Niobrara, originally created as a bird reservation, are big-game preserves and 69 are bird reservations.

(2) During 1918: Permanent warden service has been maintained on the big-game preserves and on some of the most important bird reservations, while on certain other reservations temporary warden service was afforded during the nesting season. Satisfactory increases of game animals on the refuges and a general increase in bird life on practically all the reservations are reported.

*Assignment.*—George W. Field.

*Proposed expenditures, 1918-19.*—\$18,135.

##### Montana National Bison Range:

*Object.*—Care of buffalo, elk, antelope, and such other big-game animals now on or which may be transferred to the range.

*Procedure.*—Permanent warden service is maintained. The animals on the range are cared for, hay is stored for winter use, the water supply is kept in good order, and fences and buildings are kept in repair.

*Cooperation.*—Reclamation Service, Office of Indian Affairs, and National Park Service.

*Location.*—Moiese, Mont.

*Date begun.*—1908.

*Results.*—Permanent warden service has been maintained and the fences and buildings kept in repair. The bison herd has increased from the original 37 head to 200 head. There are also approximately 75 elk, 34 antelope, and 7 deer now on the range.



*Assignment.*—George W. Field.  
*Proposed expenditures, 1918-19.*—\$2,800.

#### **Wind Cave National Game Preserve:**

*Object.*—The establishment and maintenance of a national game preserve in the Wind Cave National Park.

*Procedure.*—The purchase of additional land, keeping fences and buildings in repair, and maintaining an efficient warden service to protect and care for the game animals located on the preserve.

*Cooperation.*—National Park Service, American Bison Society, and Boone and Crockett Club.

*Location.*—Wind Cave National Park, S. Dak.

*Date begun.*—1912.

*Results.*—The private holdings of land within the Wind Cave National Park have been acquired. A game preserve of 4,160 acres has been inclosed by a substantial 88-inch woven-wire fence, and this fence has been protected by a fire guard along the exposed sections. The preserve has been stocked with big game, which now includes 34 bison, 71 elk, and 10 antelope.

*Assignment.*—George W. Field.

*Proposed expenditures, 1918-19.*—\$3,200 (\$1,200 carried over from 1918).

#### **Winter Elk Refuge:**

*Object.*—To insure perpetuation of the elk in Wyoming through the establishment of a permanent winter refuge and the raising of hay to feed the animals through severe winters.

*Procedure.*—The acquisition of land for a winter range and the production of hay sufficient to insure feed for the elk herds during severe winters in order to prevent great losses by starvation. This includes fencing, maintenance of the hay lands in productive condition, cutting and stacking the crop, and feeding the elk which are forced down into the valley during severe winters.

*Cooperation.*—Forest Service and State game officials.

*Location.*—Jackson Hole, Wyo.

*Date begun.*—1912.

*Results.*—(1) Prior to 1918: One thousand seven hundred and sixty acres of land have been purchased and 840 acres of public land added, making the present area of the reservation 2,500 acres.

(2) During 1918: Five hundred and sixty tons of hay were produced on the refuge and some 450 tons fed to the elk during the past winter. The maximum number of elk on the feeding grounds at any one time in and near the refuge was estimated at about 8,000.

*Assignment.*—George W. Field.

*Proposed expenditures, 1918-19.*—\$4,000.

#### **Sullys Hill National Game Preserve:**

*Object.*—The improvement and maintenance of a game preserve in the Sullys Hill National Park for the preservation of birds and game mammals.

*Procedure.*—The construction and maintenance of a suitable inclosure, with necessary corrals, sheds, and buildings, and the maintenance of warden service for the proper care of the animals and birds placed therein.

*Cooperation.*—National Park Service, American Bison Society, State officials, and individuals.

*Location.*—Sullys Hill National Park, N. Dak.

*Date begun.*—1914.

*Results.*—A substantial 88-inch woven-wire fence 6 miles in length, inclosing some 700 acres of land, and headquarters, including a five-room frame cottage and a frame barn, were completed. There are 14 elk and 5 deer in the preserve.

*Assignment.*—George W. Field.

*Proposed expenditures, 1918-19.*—\$3,400 (carried over from 1918).

[Extension.]

#### **Restocking Reservations:**

*Object.*—To stock national game preserves and other reservations with big game and game birds adapted thereto.

*Procedure.*—Elk are captured and transported from Jackson Hole, Wyo., and the Yellowstone National Park for distribution to Federal and State reservations and municipal parks. Antelope and other game mammals and birds are also secured and transported to reservations.

*Cooperation.*—National Park Service, Forest Service, State game departments, and individuals.

*Location.*—Various points in Arizona, Montana, Nebraska, North Dakota, South Dakota, and elsewhere.

*Date begun.*—1911.

*Results.*—(1) Prior to 1918: Elk were transported to various parts of the country, including parks and national forests situated in Washington, Oregon, Montana, Colorado, Wyoming, Arizona, Utah, North Dakota, South Dakota, Nebraska, Oklahoma, and North Carolina; buffalo were transferred from the Yellowstone Park and antelope from Alberta to Wind Cave Game Preserve in South Dakota.

(2) During 1918: Through cooperation with the National Park Service, as a nucleus a herd of six mule deer was transferred from the Yellowstone National Park to the National Bison Range, Mont.

*Assignment.*—George W. Field.

*Proposed expenditures, 1918-19.*—\$2,500.

**Total, Establishment and Maintenance of Mammal and Bird Reservations,** \$40,800, including \$1,200 statutory (regulation, \$37,900; extension, \$2,900).

**Total, Game Preservation,** \$65,100, including \$3,500 statutory (regulation, \$60,080; research, \$2,120; extension, \$2,900).

## ECONOMIC INVESTIGATIONS.

### Supervision:

*Object.*—To organize, inspect, and direct the staff employed in the execution of the law providing for investigating the food habits of North American birds and mammals in relation to agriculture, horticulture, and forestry, and to carry on clerical and other routine work necessary to the proper conduct of this project group.

*Cooperation.*—Forest Service, States Relations Service, and State experiment stations.

*Location.*—Washington, D. C., and many points in the United States mentioned under "Location" in other projects of this group.

*Date begun.*—1905.

*Assignment.*—A. K. Fisher, W. B. Bell.

*Proposed expenditures, 1918-19.*—\$11,400 (regulation, \$10,600; research \$800).

[Regulation.]

### Destruction of Injurious Mammals:

*Object.*—To devise and demonstrate methods for controlling wild mammals destructive to agriculture, animal husbandry, range lands, and forestry; to collect information relative to the kind and amount of damage done by them; and to publish and otherwise disseminate this information.

*Procedure.*—Experiments in poisoning, trapping, fumigating, and otherwise destroying noxious mammals; determination of the most practical and economical methods for controlling them; and work by field parties in destroying injurious mammals on Government reserves, public range lands, and Government tracts, which decrease their productiveness and serve to keep up infestation of private lands in agricultural districts. Demonstrations and advisory assistance are given to organizations and individuals in organizing campaigns for the repression or extermination of mammal pests on private lands. Assistance is also given individuals and organizations for the repression or extermination of mammal pests which destroy food products in manufacturing plants, warehouses, and other commercial establishments.

*Cooperation.*—Forest Service, Indian Office, and Reclamation Service cooperate in destroying injurious animals on land under their control. The North Dakota and Montana agricultural experiment stations cooperate in State-wide demonstrations of methods and organized campaigns to control rodent pests. County officers have cooperated in connection with



jack-rabbit, ground-squirrel, and prairie-dog control campaigns. State agricultural college extension service representatives throughout the West have lent valuable cooperative aid in planning and calling demonstration meetings and assisting in organizing extermination campaigns within their jurisdictions. Project agreements of cooperation with this bureau have been entered into with Arizona, New Mexico, Colorado, Idaho, Oregon, Montana, North Dakota, Utah, and Wyoming. Cooperative work is also carried on with stockmen's and farmers' clubs and with individuals in infested areas.

*Location.*—Prairie-dog extermination work is being conducted on the Apache, Coconino, Sitgreaves, and Prescott National Forests of Arizona; the Carson, Alamo, and Datil Forests of New Mexico; the Cochetopa, Rio Grande, Leadville, Durango, Gunnison, and Pike Forests of Colorado; the Custer National Forest and Crow Indian Reservation of Montana, and also on extensive areas of public lands in the vicinity of Newcastle and Manville, Wyo., and Edgemont, S. Dak. Plans for the fiscal year 1919 include the continuance of work on these areas and on a number of additional forests. Demonstration work is carried on and advisory assistance given in the control of injurious animals on privately owned areas to a greater or less extent during favorable seasons in California, Colorado, Idaho, Indiana, Iowa, Ohio, Oregon, Oklahoma, Kansas, New York, Nevada, Nebraska, North Dakota, Montana, South Dakota, Texas, Washington, Wyoming, and Virginia.

*Date begun.*—1905.

*Results.*—(1) Prior to 1918: Investigations have included methods of controlling prairie-dogs, ground squirrels, jack, cottontail, and snowshoe rabbits, pocket gophers, meadow, pine, and white-footed mice, woodchucks, cottonrats, muskrats, kangaroo rats, chipmunks, common rats, house mice, and moles. The results of these investigations have been widely disseminated by means of publications and demonstrations. Thirty-one publications covering the control of injurious mammals and 10 relating to the conservation and utilization of valuable forms have been issued. More practical methods of control and increased demonstrations resulted in further cooperation by landowners and State and county officials. During the fiscal year 1917, 797,459 acres of Government land were practically cleared of prairie-dogs.

The demonstration of methods of ground-squirrel control in North Dakota, which has been carried on during the past four years in cooperation with the State experiment station and extension service, has developed into a systematic organization including many additional counties. Cooperative poisoning was taken up with a township as a unit, and the North Dakota State law which provides for the extermination of ground squirrels on all resident and nonresident lands within a township was put into effect. The result of this organization has been the proper distribution of approximately 20,000 ounces of strychnine within this area during March, April, and May, 1917. Approximately 4,500,000 acres of heavily infested land was treated in North Dakota, in addition to follow-up work on 5,000,000 acres which had been poisoned in previous campaigns. This systematic covering of large areas of contiguous territory is the only way by which permanent relief may be had from the depredations of rapidly spreading pests, and under the system being employed in North Dakota a total extermination of the ground squirrels eventually may be expected.

(2) During 1918: Efforts to improve the poison formulas in use in the bureau were conducted during the fiscal year 1918.

During the first six months 497,206 acres of land were practically cleared of prairie-dogs. This brings the total acreage of valuable grazing lands under Government ownership which have been freed of prairie-dogs since the commencement of this work up to approximately 2,900,000 acres, resulting in a 50 per cent improvement of forage conditions.

During this year pocket gophers have been eradicated from 13,000 acres of the best grazing lands on the Ochoco National Forest in Oregon. At the same time extensive experimental investigations of methods were carried on.

Through an agreement with manufacturers, arrangements have been made under which local authorities cooperating with the bureau in extermination work may purchase strychnine and saccharine at much



lower prices than local authorities have been paying for these materials. In many cases the prices paid have been more than 100 per cent higher than those paid by the bureau.

From the funds set aside for use under this project certain expenditures have been made in carrying on demonstrations in Texas for the destruction of wolves, coyotes, and other predatory animals. The number of animals taken in this work are included in the results shown under the project "Destruction of Predatory Animals in National Forests and on the Public Domain."

Publications issued since July 1, 1917: Farmers' Bulletin 896, "House Rats and Mice," and Department Yearbook articles (1917), "Cooperative Campaigns for the Control of Ground Squirrels, Prairie-Dogs, and Jack Rabbits" and "The House Rat: The Most Destructive Animal in the World." In press: Farmers' Bulletin 932, "Rodent Pests of the Farm." In preparation: "Breeds of Domesticated Rabbits."

*Assignment.*—A. K. Fisher, W. B. Bell.

*Proposed expenditures, 1918-19.*—\$97,520.

(See also Supplement—Emergency Activities, p. 580.)

#### [Research.]

### Relation of Native and Introduced Birds to Agriculture:

*Object.*—To determine what native and introduced birds are beneficial to agriculture, horticulture, and forestry and what species are injurious; to publish and otherwise disseminate this information; to devise and recommend methods of encouraging the beneficial species and controlling the injurious ones; and to act as an information bureau upon all points touching this project.

*Procedure.*—The relations of birds to agriculture are ascertained by work along two main lines: Field observation, including the collection of stomachs of birds; and laboratory examination and tabulation of the contents of stomachs. Future work will deal with groups of birds not yet studied, with revisions of earlier investigations, and with local problems as to the relation of birds to outbreaks of destructive pests. Methods of attracting birds in all parts of the United States will be published. In cases of damage by birds, means of control will be sought. Further studies will be made of the feeding habits and natural food supply of wild fowl.

*Cooperation.*—Entomologists and botanists in the United States National Museum, the Bureaus of Entomology and Plant Industry, and in other institutions. Individuals also assist in identifications, and much material is contributed by them.

*Location.*—Washington, D. C., Minnesota, North Dakota, Arkansas, Texas, Virginia, North Carolina, and New Mexico; cooperators in numerous localities.

*Date begun.*—1885.

*Results.*—(1) Prior to 1918: (a) A fund of exact information on the relations of birds to agriculture that is unequalled anywhere has been built up. (b) Information on the economic status of no fewer than 490 species of birds has been published. This information and the arguments based upon it without doubt have been the greatest single factor contributing to the enactment in the United States of the best system of bird protective laws in existence. (c) Important information has been disseminated upon the provision of nest boxes for birds, increasing their food supply, and otherwise augmenting their numbers. It has been shown that taking proper steps along these lines results in a several-fold increase in the bird population of treated areas and means decreased losses from the depredations of injurious insects. (d) Similar work has been carried on looking toward the improvement of feeding grounds of our most important group of game birds, the wild ducks. Valuable results have already been accomplished, and an increasing number of game commissions and organizations of sportsmen are making use of these results.

(2) During 1918: On account of their importance in relation to food conservation, the food habits of fish-eating birds were given intensive study, which is still in progress. The bureau's entire collection of the stom-



achs of these birds, numbering thousands, was examined and important quantities of material were borrowed from other collections. Examinations were completed also for the pine siskin, pipits, longspurs, and red-eyed vireo and miscellaneous analyses made of a considerable variety of other birds. An investigation was made of damage to rice by wild ducks and blackbirds in Arkansas and Texas and of damage to duck-feeding grounds by swans in Virginia and North Carolina. Publications issued: Department Bulletins—619, "Food Habits of the Swallows, A Family of Valuable Native Birds," and 621, "The Crow and Its Relation to Man;" Farmers' Bulletins—844, "How to Attract Birds in the Middle Atlantic States," and 912, "How to Attract Birds in the East Central States." In press: "The Duck Sickness in Utah." Manuscripts completed: "Food Habits of the Gadwall and Baldpate," "Food Habits of the Pintail and Wood Duck," "Lead Poisoning in Waterfowl," "The Economic Value of the Starling in the United States," "The Relation of the Crow to Agriculture," "Attracting Birds to Public and Semipublic Reservations," "Wild Ducks and Duck Foods of the Bear River Marshes, Utah," and an illustrated lecture on "The Value of Birds." In preparation: "The Starling in Its Relation to Agriculture," "Food Habits of Some Winter Bird Visitors," "Report on the Wild-Duck Foods of North Dakota," "Food Habits of the Phalaropes, Avocets, and Stilts."

*Assignment.*—W. L. McAtee, E. R. Kalmbach.

*Proposed expenditures, 1918-19.*—\$19,000.

### **Rearing Fur-Bearing Animals:**

*Object.*—To ascertain the species of fur animals suitable for domestication and the best methods of feeding, confining, and otherwise handling them; to produce improved strains by selective breeding; to investigate the effects of various climatic conditions on a given strain or breed; and to test methods of dressing peltries and preserving furs.

*Procedure.*—A variety of fur animals are kept in different kinds of inclosures and fed on different kinds of food. Their behavior and condition under constant observation are recorded. They are mated with reference to specific characteristics. Individuals from the same source are kept in localities differing in climate. The parasites and diseases affecting domesticated fur animals are studied. Skins are dressed by different processes and stored under different conditions. The experience of others in each of these lines is obtained whenever possible.

*Cooperation.*—The Smithsonian Institution has given valuable information about the management of fur-bearers in confinement and at various times has cared for animals employed in this project at the National Zoological Park. The Bureau of Fisheries of the Department of Commerce has rendered an important service by furnishing blue foxes from the Pribilof Islands in the Bering Sea. Many individuals engaged in fur farming report the progress of their work and send specimens of fur-animal parasites from time to time to this bureau.

*Location.*—Linden, Md., and township of Chesterfield, N. Y.

*Date begun.*—1912.

*Results.*—(1) Prior to 1918: Experiments with minks had been conducted five years, with martens three years, and with blue foxes, fishers, and skunks one year each. Temporary structures, including an ice house, a workshop and storehouse, a meat-drying house, and a dam for an ice pond, were completed. Publications issued: Farmers' Bulletins—496, "Raising Belgian Hares and Other Rabbits"; 583, "The Common Mole of Eastern United States"; 706 and 783, "Laws Relating to Fur-Bearing Animals" (1915 and 1916, respectively); and 795, "The Domesticated Silver Fox"; and Yearbook article (1916) "Fur Farming as a Side Line."

(2) During 1918: The experimental fur farm situated in the township of Chesterfield, N. Y., was developed as far as available resources permitted. A fisher yard, a skunk yard, a marten yard, and a watchtower have been built. Publications issued: Farmers' Bulletins—587, "Economic Value of North American Skunks" (revised); 832, "Trapping Moles and Utilizing Their Skins"; 869, "The Muskrat as a Fur Bearer"; and 911, "Laws Relating to Fur-Bearing Animals, 1917." In preparation: "Value and Protection of North American Fur Animals."

*Assignment.*—A. K. Fisher, Ned Dearborn.

*Proposed expenditures, 1918-19.*—\$7,500.



**(Investigation of Disease of Wild Ducks in Salt Lake Valley, Utah:** This project was completed during the fiscal year 1917. The cause of a disease producing the death of many wild ducks in this locality has been ascertained and methods of control devised. A preliminary report was published as Department Bulletin 217, "Mortality among Waterfowl around Great Salt Lake, Utah." A final report, Department Bulletin 672, entitled "The Duck Sickness in Utah," is in press.)

[Regulation.]

**Destruction of Ground Squirrels in National Forests and on Other Public Lands:**

*Object.*—The development and application of practical methods to control ground squirrels in national forests and on other public lands and to prevent injury by them to range areas and invasion by them of private lands surrounded by or adjacent to Government lands. These rodents serve as carriers of the bubonic plague and other disease-producing organisms.

*Procedure.*—Poisoning and otherwise destroying these animals in infested areas by field parties under experienced assistants.

*Cooperation.*—County officers and landowners cooperate by poisoning private lands within and adjacent to the areas of Government land being poisoned, thereby preventing reinfestation.

*Location.*—Work is being performed in the Sequoia and California National Forests in California, the Minidoka Forest in Idaho, the Fort Totten Indian Reservation in North Dakota, and on public land adjoining the Modoc Forest in California.

*Results.*—During the fiscal year 1917, 208,553 acres of public lands were practically cleared of ground squirrels. During the current fiscal year 168,840 acres have been cleared. The number of acres of public lands which had been cleared of this pest up to the close of the calendar year 1917 aggregated 784,687. The cost per acre of exterminating this rodent has steadily decreased until the current fiscal year when, owing to the increased cost of supplies and labor due to war conditions, there will be considerable advance in the cost of rodent extermination work.

*Assignment.*—A. K. Fisher, W. B. Bell.

*Proposed expenditures, 1918-19.*—\$15,000.

**Destruction of Predatory Animals in National Forests and on the Public Domain:**

*Object.*—Systematic and economic control and eradication on the Government reserves and other public domain of wolves, coyotes, and other mammals destructive to live stock; control and suppression of wild animals likely to become infected with rabies, an epidemic of this disease being prevalent among predatory wild animals in the western United States; collection of information on the losses occasioned by such animals; and the discovery of breeding dens and destruction of the adult animals and their young.

*Procedure.*—The infested region is divided into eight districts, each under the supervision of a competent inspector. The work of these local inspectors is under the immediate direction of an inspector at large, who is constantly in the field studying and improving methods. Hunters and trappers are employed in each district at salaries ranging from \$75 to \$135 per month, including the use of horses and equipment furnished by them. The hunters are not allowed to receive bounties from any source, and the skins of the fur-bearing animals taken are received by the bureau and sold, the proceeds being turned into the United States Treasury. Hunters are placed where loss of live stock is greatest, rather than in sections where predatory animals may be more numerous but less destructive.

*Cooperation.*—The Indian Office will assist in the work. The Forest Service is cooperating and will give valuable assistance by keeping in touch with the work and informing the bureau concerning conditions and the results accomplished. Cooperation is also carried on with State and local authorities, with National, State, and county live-stock associations, and with individuals.

*Location.*—National forests and other public domain.

*Date begun.*—1915.



*Results.*—(1) Prior to 1918: It is necessary to show the statistical results under this project in combination with that of "Suppression of Rabies in Predatory Wild Animals," as the work of destroying predatory wild animals is carried on by a single organization operating under the two projects. During the fiscal year 1917 a total of 30,512 predatory wild animals were destroyed, including 107 mountain lions, 556 wolves, 22,342 coyotes, and 3,053 bobcats, the remainder of the total being made up of various other species.

(2) During 1918: The existing organization has developed in efficiency with marked reductions in loss of live stock. Included in the following figures are animals taken in Texas through demonstrations being carried on with funds from the project, "Destruction of Injurious Mammals," and through the use of cooperative funds in that State. During the first eight months of the current fiscal year 19,055 predatory animals were destroyed, including 43 mountain lions, 236 wolves, 13,798 coyotes, and 1,838 bobcats, the remainder of the total being made up of various other species. During the same period, through operations carried on by the bureau with funds furnished by State authorities, live-stock associations, and individuals, there were destroyed 4,909 predatory animals, including 1 mountain lion, 34 wolves, 3,708 coyotes, and 418 bobcats. It is certain that poison campaigns against these animals, in connection with which there is no record of the number killed, were responsible for the destruction of many thousands additional. Since the beginning of this project in 1915 there has been realized from the sale of skins of the predatory animals taken by the Government hunters \$57,714.55, which sum has been turned into the United States Treasury. In addition, there are now on hand a large number of skins awaiting sale. Cooperation from live-stock associations and individuals is constantly increasing, funds being provided to pay the salaries and furnish supplies for hunters in addition to those employed by the Government. A number of the States have made appropriations in substantial amounts for carrying, funds being provided to pay the salaries and furnish supplies for tion of this bureau.

*Assignment.*—A. K. Fisher, W. B. Bell.

*Proposed expenditures, 1918-19.*—\$125,000.

(See also Supplement—Emergency Activities, p. 580.)

### **Suppression of Rabies in Predatory Wild Animals:**

*Object.*—An epizootic of rabies prevails among the predatory wild animals, including coyotes, bobcats, and others, in the western United States. This disease is communicated by these animals to human beings and to stock and other domestic animals. The object of this project is the destruction of the wild animals which are spreading the disease.

*Procedure.*—The only satisfactory method for the suppression of this disease is the destruction of the afflicted predatory animals. The infested region having been divided into districts under the project, "Destruction of Predatory Animals in National Forests and on the Public Domain," with an inspector in charge of each district, the work is supervised by the existing organization. Additional inspectors and hunters have been employed. The methods which obtain in the predatory-animal work are followed.

*Cooperation.*—States, live-stock associations, the Forest Service, and individuals.

*Location.*—Rabies-infested and adjacent territory in Oregon, California, Nevada, Idaho, and Utah.

*Date begun.*—1916.

*Results.*—It is necessary to show the statistical results under this project in combination with that of "Destruction of Predatory Animals in National Forests and on the Public Domain," as the work of destroying predatory wild animals is carried on by a single organization operating under the two projects. During the past fiscal year the existing organization has developed in efficiency, with marked reductions in the loss of domestic live stock.

*Assignment.*—A. K. Fisher, W. B. Bell.

*Proposed expenditures, 1918-19.*—\$125,000.

(See also Supplement—Emergency Activities, p. 580.)

**Total, Economic Investigations, \$400,420, including \$5,600 statutory (regulation, \$373,120; research, \$27,300).**



## [Research.]

## BIOLOGICAL INVESTIGATIONS.

**Supervision:**

*Object.*—Supervision and direction of field and laboratory investigations and general correspondence.

*Location.*—Washington, D. C., and throughout the United States where field work is being conducted.

*Date begun.*—1905.

*Assignment.*—E. W. Nelson, E. A. Preble.

*Proposed expenditures, 1918-19.*—\$4,540.

**Investigations of Birds and Mammals of the Public Domain:**

*Object.*—To secure and publish definite information concerning the habits and distribution of bird and mammal life of the public domain, particularly in the national forests and Federal preserves, with special reference to the fur-bearers and species classed as game. This information is desired to assist in the conservation of valuable species, particularly game birds and mammals, and for the purpose of supplying accurate information necessary in the restocking of areas in which the species have become extinct. Information is also gathered concerning the habits and distribution of noxious species for use in connection with plans for their control. These field and laboratory investigations supply information which is constantly desired by institutions and individuals throughout the country, as well as by Government departments. It is necessary also for use in connection with other activities of the bureau.

*Procedure.*—Field naturalists conduct investigations throughout the United States, Alaska, and parts of Canada and Mexico, where observations are recorded, specimens collected, and detailed field reports made, which form the basis for laboratory investigations and reports. Information is also gathered from individuals and institutions. Expert study is made of specimens for the purpose of determining the number and relationship of the species of birds and mammals, in order that they may be differentiated, their ranges accurately mapped, and the information available properly collated. Reports are prepared from time to time for publication covering the field work of this project, also monographs of the little-known groups of mammals and birds, in order to supply information necessary in studying the relations of the species to agriculture and their value as game animals and as fur-bearers.

*Cooperation.*—State game commissions, State and other universities, agricultural colleges, scientific societies, and individuals, both in the collection and contribution of information and the loan of specimens. Men interested in large game and its conservation frequently make long and costly expeditions at their own expense to secure information and specimens to forward the investigations of the bureau, and in some cases have contributed money for these purposes.

*Location.*—Washington, D. C., and many points throughout the United States, Canada, and Mexico.

*Date begun.*—1885.

*Results.*—The accumulation of a vast fund of information concerning the bird and mammal life of North America, particularly the species valuable for game and as fur-bearers and those injurious to agriculture. The data on file resulting from this project and allied lines of work have become so extensive that the Bureau of Biological Survey has now become a clearing house for information on these subjects. Letters of inquiry are constantly received from all parts of the United States, Canada, and Mexico concerning the identity of species, and their habits, value, and relation to agriculture. State authorities also consult this section of the bureau for information concerning the identity of scalps submitted for bounties, in order to prevent fraud. Hundreds of maps have been prepared showing the distribution of game and other mammals in North America.

Numerous publications, especially technical monographs of mammals, have been prepared and published as a result of investigations under this project, and others are in progress. The more recently issued of these publications are: North American Faunas—No. 36, "Revision of the American Harvest Mice"; No. 37, "Revision of the American Marmots"; No. 38, "A Review of the American Moles"; No. 39, "Revision of the



Pocket Gophers of the Genus *Thomomys*"; No. 40, "A Systematic Account of the Prairie-Dogs"; and No. 41, "Review of the Grizzly and Big Brown Bears of North America." Those in preparation are: No. 44, "Revision of the American Flying Squirrels," in press; No. 43, "The Rice Rats of North America," in press; and "Revision of the American Shrews."

*Assignment.*—E. W. Nelson, E. A. Preble.

*Proposed expenditures, 1918-19.*—\$10,440.

### **Biological Surveys of the States and Territories:**

*Object.*—To determine the distribution, abundance, and habits of the birds and mammals of the United States and the distribution of the principal plants, in order to secure information for publication which will be of use to the public in the conservation of the bird and mammal life and to obtain data by which the boundaries of the natural life zones may be determined. The life-zone work in each State serves as a unit in completing the mapping of the life zones of the entire United States.

*Procedure.*—Skilled field naturalists traverse the State, working the mountains, valleys, and plains in sufficient detail to learn the distribution of birds, mammals, and principal plants. Specimens of each of these groups needed for identification and study are collected from many stations at varying altitudes. Detailed field notes on the habits of birds and mammals are made, especially in reference to their food habits, and stomachs are saved for examination in the laboratory. Reports are required from field men at the end of the work at each temporary station covering observations on the physiography of the district, the characteristic vegetation, and the birds and mammals. This field work continues until the State is covered in sufficient detail to warrant final reports, which are prepared in Washington from a study of specimens and collation of field data. Much information is gained also by correspondence and the study of specimens loaned by institutions and individuals.

*Cooperation.*—In Arizona, the State fish and game commission and individuals; in Florida, the Florida State Museum; in Montana, the State Board of Entomology; in Wisconsin, the University of Wisconsin; and in Washington, the State College of Washington.

*Location.*—Active field work on biological surveys will be continued in Washington, California, Arizona, Montana, Florida, and Wisconsin.

*Date begun.*—The general project was begun in 1889; work in New Mexico was begun in 1903; Alabama, 1908; Arizona, 1909; Wyoming, 1910; North Dakota, 1912; Oregon, 1914; Montana, 1916; Wisconsin, 1917; Florida, 1918.

*Results.*—(1) Prior to 1918: Field work in New Mexico has been completed, the report of life zones has been published, and reports on mammals and birds are being prepared; field work in Texas completed, a report on life zones and mammals published, and a report on birds completed; work in Colorado finished and a report on life zones and mammals published; work in Wyoming finished, a report on life zones published, and one on mammals practically ready for publication; work in Alabama completed, report on the birds completed, and one on the mammals nearly completed. In many other States a large amount of work has been done and extensive field notes and series of specimens gathered to be used later when it is possible to complete the work.

(2) During 1918: Field work in Arizona about 90 per cent completed, and California nearly completed; in Alabama field work on mammals was completed; considerable progress was made in Montana, Washington, and Wisconsin; a biological survey of Florida was started.

The more recent publications issued include the following numbers of North American Faunas: No. 25, "Biological Survey of Texas," including reports on life zones, reptiles, and mammals; No. 33, "A Biological Survey of Colorado," including reports on the life zones and mammals; No. 35, "Life Zones and Crop Zones of New Mexico"; and No. 42, "Life Zone Investigations in Wyoming," including notes on conspicuous trees and shrubs. Ready for publication: "Bird Life of Texas"; "The Birds of New Mexico"; "Mammals of New Mexico"; "Birds of Alabama," including discussion of physical features of the State and annotated list of the birds; "Mammals of Wyoming," practically completed. In preparation: "Mammals of Alabama."



*Probable dates of completion.*—Work in the following States, including preparation of reports, will probably be completed as indicated: North Dakota, 1919; Oregon, 1920; Wyoming, 1918 (completed); Arizona, 1920; Alabama, 1919 (completed); New Mexico, 1919 (completed); Montana, 1922; Washington, 1921; Wisconsin, 1921; Florida, 1921; California, 1919.

*Assignment.*—E. W. Nelson, Vernon Bailey.

*Proposed expenditures, 1918-19.*—\$14,460.

### **Bird Migration:**

*Object.*—To determine for each species of bird in the United States its breeding and wintering places and the routes by which it passes from winter to summer home and return, and to determine the times of its migration and the extent of its wanderings out of its regular range. This information is for use in connection with studies of the relation of birds to agriculture and in the proper administration of the migratory-bird treaty act. It is also useful in determining proper open and closed seasons for game birds in the various States.

*Procedure.*—Persons located in many parts of the United States interested in the study of birds and sufficiently acquainted with the species record the arrival and departure of the birds during migration, note the species which breed in their neighborhood and those which winter there, and report their observations to the department. The reports of field men also supply much of this information. In addition, data are obtained from published information in scientific journals. These facts are collated in card files and the results plotted on maps, which thus show at a glance the movements of the species and their summer and winter homes. During 1918-19 the gathering and collating of data from available sources will be continued and efforts made to secure information concerning migratory waterfowl for use in connection with the administration of the migratory-bird treaty act.

A count of the birds breeding on certain typical areas of farm, orchard, and forest land has also been undertaken, the reports being made by voluntary observers in various parts of the country, to ascertain the conditions most favorable for the useful species, with the object of increasing their numbers.

*Cooperation.*—About 375 volunteer observers are now sending in migration reports, and about 150 are sending reports of counts.

*Location.*—Washington, D. C., and hundreds of localities throughout the United States and southern Canada.

*Date begun.*—1885.

*Results.*—Migration reports have been received from more than 2,000 volunteer observers. These notes, together with those obtained from publications and the observations of field men of the bureau, are tabulated on more than 1,300,000 cards. Reports have been published on the migratory movements of 255 species, and bulletins on 52 additional species have been completed for publication. Provisional maps of the breeding ranges have been completed for each species breeding in the United States and for about one-third of the breeding ranges of those breeding in Canada. The winter ranges have been mapped for more than 200 species and migration maps for a large number.

Among the more recent publications issued are: Department Bulletins—128, "Distribution and Migration of North American Rails and Their Allies"; 185, "Bird Migration"; 187, "Preliminary Census of Birds of the United States"; 292, "Distribution and Migration of North American Gulls and Their Allies"; and 396, "Second Annual Report of Bird Counts in the United States"; Department Yearbook articles—1910, "The Migratory Movement of Birds in Relation to the Weather," and 1914, "Our Shorebirds and Their Future"; and Biological Survey Circular 84, "Distribution of American Egrets." In preparation: "Distribution and Migration of North American Terns and Their Allies," completed; "Distribution and Migration of North American Grebes, Loons, and Auks," nearly completed; Biological Survey Bulletin 26, "Distribution and Migration of North American Ducks, Geese, and Swans," revised edition with distribution maps, partly completed.

*Assignment.*—E. W. Nelson, H. C. Oberholser.

*Proposed expenditures, 1918-19.*—\$3,900.

**Total, Biological Investigations, \$33,340, including \$7,740 statutory.**



**ENFORCEMENT OF THE MIGRATORY-BIRD TREATY ACT.****Supervision:**

*Object.*—To supervise, direct, and control the office and field activities in connection with the administration of the migratory-bird treaty act to give effect to the treaty between the United States and Great Britain for the protection of birds migrating between the United States and Canada.

*Cooperation.*—Associations and individuals interested in the conservation of wild life.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Assignment.*—George A. Lawyer.

*Proposed expenditures, 1918-19.*—\$9,720 (regulation, \$9,330; research, \$390.)

**[Regulation.]****Protection of Migratory Birds:**

*Object.*—The protection of migratory game and insectivorous birds under the terms of the act of Congress approved July 3, 1918, and the regulations issued thereunder by the Department of Agriculture.

*Procedure.*—The United States is divided into 13 districts, under the supervision of 15 game wardens. Investigations are made of violations of the migratory-bird treaty act, and evidence is secured and submitted to the solicitor of this department for transmission to the Department of Justice for prosecution. Employees of the department also arrest persons committing violations in their presence and take such persons immediately before a United States commissioner for examination. Valuable information is gathered and disseminated, whereby the public is educated as to the objects and necessity of the law for the protection of migratory birds. Cooperation is maintained between the bureau and the game departments of the several States in the protection of migratory birds and data secured to enable the bureau to administer the law intelligently. The administration will be continued along the lines already begun. By a campaign of education efforts are made to interest the people at large and to demonstrate to sportsmen and gunners the necessity for the proper observance of the regulations under the treaty act.

*Cooperation.*—Solicitor of the department, game departments of the several States, game protective associations, Audubon societies, and individuals throughout the United States.

*Location.*—Washington, D. C., and the several States. Headquarters of game wardens are as follows: Los Angeles, Cal., Little Rock, Ark., Hinsdale, Ill., Atchison, Kans., Russellville, Ky., New Orleans, La., Lowell, Mass., St. Louis, Mo., Lackawanna and Owego, N. Y., Manteo, N. C., Portland, Oreg., Locustville, Va., Spokane, Wash., and Ashland, Wis.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: Organization of the United States into 13 districts under 17 inspectors, about 200 Federal wardens, and 5 game protectors; effective cooperation with most of the State game departments; 769 cases of violations reported and prepared for prosecution. As a result of the abolition of spring shooting and the protection afforded through the enforcement of the regulations, there has been a gratifying increase of all species of migratory birds. Birds that heretofore have been forced to Canada and the extreme North by incessant shooting have, under the protection afforded, become comparatively tame and are remaining in ever-increasing numbers to breed within our borders.

(2) During 1918: Laws for the protection of migratory birds in nine States were made to conform with the seasons under the Federal regulations; 261 cases of violations were reported and prepared for prosecution, making a total of 1,030 cases since operations were begun. As a result of the activities of game wardens cooperating with State officials and sportsmen, violations have been reduced to a minimum in most States. In a few sections, however, serious outbreaks of violations have occurred which could not be handled effectively because of inadequate powers of enforcement under the migratory-bird law of 1913. State game commissioners with one accord have approved the migratory-bird treaty act



and recommended its continuance. There has been a gradual and continuous increase in all species of migratory birds up to the present time, and the number of birds breeding in the United States also has increased to a large extent.

*Assignment.*—George A. Lawyer.

*Proposed expenditures, 1918-19.*—\$48,758 (including \$9,078 reappropriated by the act of July 3, 1918).

[Research.]

**Investigation of Migratory Wild Fowl:**

*Object.*—To investigate the distribution and abundance of migratory wild fowl in their breeding and wintering resorts, in order to obtain data concerning the increase or decrease of the species as a basis for changes in the regulations under the migratory-bird treaty act. This inquiry will show the effect of the law in the conservation of wild fowl and will give needed information concerning the locations where the birds congregate during the breeding and wintering seasons. As a result of this work it will be possible, when advisable, to locate areas which should be set aside as preserves in order to help conserve the species. It will also be possible to facilitate measures for increasing the species by safeguarding and possibly increasing their food supply.

*Procedure.*—Skilled field naturalists familiar with the species make careful surveys of the breeding and wintering resorts of the wild fowl. They determine approximately the absolute as well as the relative numbers of the species in each locality and definitely locate the areas where the largest numbers of birds congregate during the different seasons. Full reports are made, accompanied by maps. Later on reports will be prepared for publication covering various areas, in order that the information procured may be available for the public.

*Cooperation.*—State game organizations, sportsmen's clubs, and individuals.

*Location.*—Washington, D. C., and many scattered areas throughout the United States.

*Date begun.*—1915.

*Results.*—Much information has been obtained from several localities, particularly in Nebraska, North Dakota, South Carolina, Minnesota, New Jersey, and Florida, concerning the abundance and occurrence of wild fowl with reference to the influence of the migratory-bird law. A report was published in the Department Yearbook for 1917 entitled "The Great Plains Waterfowl Breeding Grounds and Their Protection." A report on the wild fowl of Nebraska is ready for publication.

*Assignment.*—E. W. Nelson, H. C. Oberholser.

*Proposed expenditures, 1918-19.*—\$2,000.

**Total, Enforcement of the Migratory-Bird Law, \$60,478, including \$1,400 statutory and \$9,078 reappropriated by the act of July 3, 1918 (regulation, \$58,088; research, \$2,390).**



## BUREAU OF CROP ESTIMATES.

### GENERAL ADMINISTRATION.

#### Office of Chief:

*Object.*—The direction of the business and other activities of the Bureau of Crop Estimates.

*Procedure.*—The work of the bureau in Washington is conducted under the direct supervision of the officials in charge. The supervision of the field force is accomplished through correspondence and regular trips of inspection by one of the bureau officials.

*Cooperation.*—Various bureaus and departments and the crop-reporting offices of some State governments.

*Location.*—Washington, D. C.

*Date begun.*—1866.

*Assignment.*—Leon M. Estabrook, Nat C. Murray.

*Proposed expenditures, 1918-19.*—\$17,304.

#### Office of Chief Clerk:

*Object.*—General supervision of expenditures and financial records, property records, duplicating work, personnel, and distribution of seeds to crop reporters.

*Location.*—Washington, D. C.

*Assignment.*—Charles E. Gage.

*Proposed expenditures, 1918-19.*—\$23,796.

**Total, General Administration, \$41,100, including \$33,860 statutory (service, \$36,990; research, \$4,110).**

[Service.]

### CROP REPORTING AND ESTIMATING.

#### General Crops and Live Stock:

*Object.*—To collect, through correspondence and field investigation, information regarding crops and live stock, and to make public timely estimates or forecasts of acreage, condition, production, and values of crops, and numbers, condition, and values of live stock, and information closely related thereto.

*Procedure.*—Data are collected, in triplicate (with few exceptions), (a) from voluntary township reporters, each reporting for his immediate locality; (b) from voluntary county reporters, each reporting for his county; and (c) from salaried field agents, each reporting for an entire State. Information is collected monthly on schedules of inquiry. Reports from township and county reporters are each compiled into State averages by a large force of clerks in Washington. Special lists of correspondents are maintained and utilized for special investigation. A crop-reporting board, consisting of the chief of bureau and several assistants, reviews the State averages, derived from the three distinct sources mentioned, for the main crops and determines the final estimates adopted by the bureau.

*Cooperation.*—Various bureaus and State and local organizations.

*Location.*—Headquarters at Washington, D. C. Each field agent has a station in the State to which he is assigned.

*Date begun.*—1866.

*Results.*—Monthly seasonable estimates by States and for the United States are made as follows:

Acreage (total): Barley, beans (dry, soy, and velvet), broom corn, buckwheat, clover seed, corn, cotton, cowpeas, cranberries, flax, grain



sorghums, hay (alfalfa, clover, tame, timothy, wild), hemp, hops, oats, peanuts, potatoes (Irish, sweet), rice, rye, sorghum for sirup, sugar beets, tobacco, wheat (spring, winter). Percentages of previous year's acreage: Clover seed, hay (alfalfa, timothy), sugar cane.

Condition, expressed in percentage of normal: Almonds, apples, apricots, barley, blackberries, raspberries, bluegrass for seed, broom corn, buckwheat, cabbage, cantaloupes, cattle, cauliflower, celery, cherries, clover seed, corn, cotton, cranberries, field beans, field peas, figs, flax, grain sorghums, grapefruit, grapes, hay (all, alfalfa, clover, millet, timothy), hemp, honeybees, hops, horses and mules, lemons, lima beans, limes, oats, olives, onions, oranges, pastures, peaches, peanuts, pears, pineapples, plums, potatoes (Irish, sweet), prunes, rice, rye, sheep, sorghum for sirup, sugar beets, sugar cane, swine, tobacco, tomatoes, walnuts, watermelons, wheat (spring, winter).

Forecasts of production, based upon condition estimates: Apples, barley, beans, broom corn, buckwheat, corn, cotton, flax, grain sorghums, hay (all), hops, oats, peaches, peanuts, pears, potatoes (Irish, sweet), rice, rye, sugar beets, sorghum sirup, tobacco, wheat (spring, winter).

Yield per acre: Alfalfa seed, barley, beans, broom corn, buckwheat, cabbage, clover seed, corn, cotton, cranberries, flaxseed, grain sorghums, grapefruit, grapes, hay (alfalfa, clover, tame, timothy, wild), hemp, hops, lemons, oats, onions, oranges, peanuts, potatoes (Irish, sweet), rice, rye, sorghum sirup, sugar beets, tobacco, wheat (spring, winter).

Production (quantitative): Apples, barley, beans (dry), broom corn, buckwheat, cabbage, clover seed, corn, cotton, cranberries, flaxseed, grain sorghums, hay (alfalfa, clover, clover and timothy, millet, tame, timothy, wild), hemp, hops, oats, onions, oranges, peaches, pears, potatoes (Irish, sweet), rice, rye, sorghum sirup, sugar beets, tobacco, wheat (spring, winter), wool.

Production, expressed in percentage of a full crop: Alfalfa (hay, seed), almonds, apples, apricots, blackberries, raspberries, bluegrass for seed, broom corn, cabbage, cantaloupes, cauliflower, celery, cherries, clover (hay, seed), cranberries, field beans (grain, forage), field peas (grain, forage), figs, grain sorghums, grapefruit, grapes, hemp, lemons, lima beans, limes, millet (hay, seed), olives, onions, oranges, peaches, peanuts, pears, pineapples, plums, prunes, sugar beets, sugar cane, timothy hay, tomatoes, walnuts, watermelons, wool.

Prices, monthly or in season: Alfalfa seed, apples, barley, beans (dry, soy), beef cattle, bran, broom corn, buckwheat, butter, cabbage, chestnuts, chickens, clover seed, corn, cotton, cotton seed, cottonseed hulls, cottonseed meal, cranberries, cowpeas, eggs, flaxseed, grain sorghums, grapefruit, grapes, hay (alfalfa, clover, tame, timothy, wild), hogs, horses, hickory nuts, honey (comb, extracted), hops, lambs, lemons, limes, maple sugar and sirup, milch cows, milk, oats, onions, oranges, peaches, peanuts, pears, pecans, pineapples, popcorn, potatoes (Irish, sweet), rice, rye, sheep, timothy seed, tobacco, tomatoes, turkeys, turnips, veal calves, walnuts, wheat, wool (washed, unwashed).

Quality: Apples, barley, buckwheat, corn, cranberries, flaxseed, grapefruit, grapes, hay (clover, tame, wild), hops, lemons, limes, oats, oranges, peaches, peanuts, pears, potatoes (Irish, sweet), rice, rye tobacco, wheat (spring, winter).

Stocks on farms, on certain dates: Barley, corn, hay, oats, potatoes, wheat.

Quantity shipped out of county where grown (State averages): Apples, barley, corn, oats, wheat.

Numbers (total): Horses, milch cows, mules, other cattle, sheep, swine. Percentage of preceding year: Breeding sows, honeybees (colonies), stock hogs.

Losses from disease or exposure: Cattle, horses and mules, lambs, sheep, swine.

Weight per unit of measure: Barley, oats, wheat (spring, winter), wool.

Miscellaneous: Apples, early and late varieties (percentage of late crop marketed); corn (percentage of merchantable quality); plowing and planting (percentage done by May 1); wages of farm labor; maple sugar and sirup (percentages and quality); yield of honey per colony.



Results are given to the public mostly through press reports, in the "Monthly Crop Report," a serial publication for free distribution, and in the Yearbook of the Department of Agriculture.

*Assignment.*—Leon M. Estabrook, Nat C. Murray, Samuel A. Jones, Edward Crane.

*Proposed expenditures, 1918-19*—\$221,806.

### Truck Crops:

*Object.*—To collect, collate, and publish information concerning the status of the truck-crop industry in the important truck-crop districts of the United States as it relates to the truck crops grown for shipment to more or less distant points, truck crops grown for manufacture, and those grown for sale at local markets.

*Procedure.*—Special lists of commercial truck-crop growers, canners, picklers, kraut manufacturers, and market gardeners are maintained, to which are sent periodically schedules of inquiry calling for the information desired for publication; also personal investigations and inspections are made by three assistant truck-crop specialists, with headquarters in the field, and one truck-crop specialist in charge, whose headquarters are at Washington, D. C.

*Cooperation.*—Bureau of Markets and Food Administration.

*Location.*—Washington, D. C., and in the field.

*Date begun.*—1914.

*Results.*—Estimates of condition, acreage, and production of early Irish potatoes, cabbages, onions, cantaloupes, watermelons, strawberries, tomatoes, lettuce, celery, cucumbers, broccoli, kale, spinach, cauliflower, asparagus, and artichokes are made in season for important districts. A weekly review is made of truck-crop conditions in important producing districts. The condition of truck crops is reported semimonthly. Estimates of acreage and packs of corn, peas, tomatoes, snap beans, cucumbers, and cabbage consumed by canneries, pickling factories, and kraut manufacturers are made yearly.

*Assignment.*—Fred J. Blair, Edward L. Roberts, H. A. Marks, R. G. Risser, C. G. Carpenter.

*Proposed expenditure, 1918-19.*—\$24,136.

### Fruit Crops:

*Object.*—To collect and publish estimates relating especially to the commercial production of fruit in the United States, as well as of agricultural or total production; to make estimates also for the principal producing regions and the leading commercial varieties. The work of 1918-19 will be confined to apples and peaches with the expectation of including other fruit crops later on.

*Procedure.*—Current information is collected, by means of correspondence and by travel of the fruit-crop specialists, regarding the prospective crop during the growing season and the actual crop after harvest. Reports from correspondents are tabulated, under the direction of the statistical clerk in charge, and the results interpreted by comparing with former inquiries and with the information furnished by reports received from the field agents and from a small list of voluntary cooperators. For method of tabulation, see "General Crops and Live Stock." Estimates, when determined, are published. In addition to the regular monthly reports, statistical surveys will be made by the fruit-crop specialists of the principal peach-producing regions, and some additional surveys will be made of apple regions.

*Cooperation.*—Various bureaus of the department and State and local organizations.

*Location.*—Washington, D. C.; one fruit-crop specialist to travel in the Eastern States, one in the Central States, and one in the West.

*Date begun.*—1917.

*Results.*—A survey of the apple-producing regions, to be used as a basis for crop estimates, was nearly completed during the 1917 season, and a survey of the peach-producing regions was begun in the spring of 1918.

By the autumn of 1917 estimates of the commercial and, to some extent, the agricultural production of apples were revised for the 1916 crop, and



1917 estimates were made in accordance with data collected in the course of the apple survey and through the voluntary correspondents. The preliminary apple work was completed before the close of the crop year and the regular estimating work begun. The first peach-crop estimate was issued early in April, 1918, being greatly facilitated by the organization already established.

The organization of a well-distributed, representative, and reliable corps of voluntary apple-crop reporters was accomplished by the statistical clerk in charge of the office work, with the cooperation of the fruit-crop specialists. The organization of a similar corps of peach-crop reporters was begun in the spring of 1918.

*Assignment.*—Frank Andrews, J. C. Folger, S. M. Thompson, J. R. Duncan, J. E. Eldridge.

*Proposed expenditures, 1918-19.*—\$15,216.

**Total, Crop Reporting and Estimating, \$261,158, including \$64,840 statutory.**  
(See also Supplement—Emergency Activities, p. 581.)

[Research.]

## CROP RECORDING AND ABSTRACTING.

### Crop Recording and Abstracting:

*Object.*—To collect from published and unpublished records statistical data relative to agriculture in the United States and foreign countries and to make such data available for study and practical use.

*Procedure.*—Reports are secured from official and authoritative private sources in the United States and foreign countries; and the desired data are reviewed, recorded, summarized, and interpreted, under the direction of statistical scientists. A statistical library is maintained in connection with this work. Reports as to acreage and production of sugar crops are made, each by means of an enumeration or census, the data being obtained from sugar makers.

*Cooperation.*—Department library, International Institute of Agriculture, various branches of this and other Federal departments; and various State officials, commercial organizations, and other agencies.

*Location.*—Washington, D. C.

*Date begun.*—1866.

*Results.*—Manuscript records of United States and foreign crops, wholesale prices, and miscellaneous agricultural statistics are kept and are used as a basis for giving information (a) in response to numerous special requests and (b) in publications. Publications in 1917-18: Department Bulletin 594, "Geography of Wheat Prices"; and three articles in the Department Yearbook for 1917, entitled respectively, "Wool: Production, Foreign Trade, Supply, and Consumption," "Hides and Skins: Production, Foreign Trade, Supply, and Consumption," and "Sugar Supply of the United States."

Special requests for crop data, both orally and by correspondence, are received at the rate of several thousand a year; replies are made from office records or from special investigations.

About one-half of the department Yearbook's statistical tables are prepared under the project "Crop Recording and Abstracting" (122 tables in 1917).

The sugar reports include (1) area of sugar beets planted (July); (2) preliminary report on production of beet sugar, and area and production of sugar beets (December); (3) final report on beet sugar and sugar beets (about April); (4) preliminary estimate of cane to be used for sugar in Louisiana (December); (5) final report of sugar and cane in Louisiana (about last of April); (6) production of sugar and area and production of cane in Hawaii (about March).

Manuscripts were submitted on "The Geography of Farm Prices: Corn" and "The Geography of Farm Prices: Oats." Additional work was done on the investigation relating to the surplus and deficiency of the agriculture of the United States.

Reports to the International Institute of Agriculture are made monthly, by mail and by radiograph (through the Navy Department), and dispatches from the institute are received and prepared for official use.



The bureau library maintains (a) files of annual reports on crops, live stock, prices, trade movements, etc., issued by the United States, individual States, commercial organizations, private concerns, and by most of the foreign governments; (b) a large collection of monthly, weekly, and daily periodicals, reports, and circulars; and (c) special publications relating to agricultural statistics.

*Assignment.*—Frank Andrews, George K. Holmes, Charles M. Daugherty, Perry Elliott, Harry D. Ruddiman.

*Proposed expenditures, 1918-19.*—\$43,974, including \$31,740 statutory.

**ALLOTMENT OF BUREAU OF CROP ESTIMATES APPROPRIATIONS BY PROJECTS.**

Project.	Statutory salaries.	General expenses.			Total.
		Adminis- trative expenses.	Field investi- gations.	Total.	
General administration:					
Office of chief.....	\$13,800	\$3,504	.....	\$3,504	\$17,304
Office of chief clerk.....	20,060	3,736	.....	3,736	23,796
Crop reporting and estimating:					
General crops and live stock.....	57,840	3,856	\$160,110	163,966	221,806
Truck crops.....	5,600	500	18,036	18,536	24,136
Fruit crops.....	1,400	400	13,416	13,816	15,216
Crop recording and abstracting.....	31,740	12,234	.....	12,234	43,974
Total.....	130,440	24,230	191,562	215,792	346,232



## STATES RELATIONS SERVICE.

### GENERAL ADMINISTRATION.

#### Office of Director:

*Object.*—General administration of the affairs of the States Relations Service.

*Cooperation.*—Other offices of the department, other departments, and State agricultural colleges and experiment stations.

*Location.*—Washington, D. C.

*Date begun.*—1888, as Office of Experiment Stations, 1915; under present organization.

*Assignment.*—A. C. True.

*Proposed expenditures, 1918-19.*—\$7,100.

#### Office of Chief Clerk:

*Object.*—To supervise the clerical and subclerical force of bureau; handle matters relating to appointments and leaves of absence; supervise central file room and property room; handle mail and review correspondence for the director.

*Cooperation.*—Other offices of the department and other departments.

*Location.*—Washington, D. C.

*Date begun.*—1902; reorganized, 1915.

*Assignment.*—Carrie E. Johnston.

*Proposed expenditures, 1918-19.*—\$30,990.

#### Accounts:

*Object.*—The systematic administration of the fiscal affairs of the bureau.

*Cooperation.*—Office of Inspection, Disbursing Office, and the Treasury Department.

*Location.*—Washington, D. C.

*Date begun.*—1906; reorganized, 1915.

*Assignment.*—F. E. Singleton.

*Proposed expenditures, 1918-19.*—\$24,120.

#### Editorial Work:

*Object.*—To edit and prepare for printing manuscripts and proofs of articles submitted for publication by members of the service, to cooperate with the Division of Publications in maintaining mailing lists and in the distribution of publications of the service, and to have charge of lantern slides and other illustrative material and job printing.

*Cooperation.*—Division of Publications and other branches of the department.

*Location.*—Washington, D. C.

*Date begun.*—1902; reorganized, 1915.

*Assignment.*—W. H. Beal.

*Proposed expenditures, 1918-19.*—\$16,330.

#### Library:

*Object.*—To collect and care for the publications of the agricultural experiment stations and the agricultural extension services; circulate and care for books and periodicals in the States Relations Service; examine domestic and foreign literature of agricultural science with reference to matters for use in the Experiment Station Record and to assign this to the editors of the journal; and perform reference and bibliographical work for the several offices of the service.

*Cooperation.*—Main department library, Library of Congress, and libraries of the State agricultural colleges and experiment stations.

*Location.*—Washington, D. C.

*Date begun.*—1888; reorganized, 1915.



*Assignment.*—Eloise L. Ogden.

*Proposed expenditures 1918-19.*—\$4,160.

**Total, General Administration,** \$82,700, including \$67,020 statutory (extension, \$65,087; research, \$13,396; regulation, \$4,217).

## RELATIONS WITH EXPERIMENT STATIONS.

### [Regulation.]

#### STATE EXPERIMENT STATIONS.

##### State Experiment Stations:

*Object.*—To administer the provisions of the acts approved March 2, 1887, and March 16, 1906, creating and endowing agricultural experiment stations; to enable the Secretary of Agriculture to certify to the Treasury Department whether Federal funds may properly be advanced to the State experiment stations and to report to Congress regarding the work and expenditures of these institutions; to furnish prompt information regarding the organization, equipment, resources, and work of experiment stations and kindred institutions throughout the world to workers in similar lines in this department and the agricultural colleges, schools, and experiment stations; and to aid the State experiment stations in the effective development of their work.

*Procedure.*—A financial report on schedules approved by the Secretary of Agriculture is received from each station and examined and approved in this office. Written and printed reports of the work and expenditures of each station are received and examined. A personal inspection of the work, account books, and vouchers of each station is made annually. On the basis of the information gained from the aforesaid sources a report on the work and expenditures of each station is annually made to Congress and distributed in this and other countries. The plans for work under the act of Congress of March 16, 1906, are reported by each station to this office and approved here in advance of their execution. The publications of agricultural institutions throughout the world are abstracted in a journal entitled "Experiment Station Record," issued in two volumes of nine numbers each and a detailed index each year. Advice and information regarding the stations are also given in large measure by correspondence and personal conference with station officers.

*Cooperation.*—The bureaus of this and other departments, the State experiment stations, and agricultural institutions in many countries.

*Location.*—Washington, D. C.

*Date begun.*—1893.

*Results.*—More careful and effective expenditure of funds granted to the experiment stations; department, station, college, and school workers regularly kept informed regarding the progress of agricultural research, and thus enabled to plan and execute their work more effectively and with less waste of effort and funds.

*Assignment.*—E. W. Allen.

*Proposed expenditures, 1918-19.*—\$48,816, including \$12,560 statutory.

### [Research.]

#### INSULAR EXPERIMENT STATIONS.

##### Supervision:

*Object.*—To exercise general supervision over the work of the experiment stations in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands of the United States.

*Procedure.*—The plans of work and expenditures of all stations are annually reported in advance to the Washington office for approval. The vouchers recording their expenditures are examined and approved here. Their annual reports and bulletins are submitted to this office for review and approval before publication. By correspondence and occasional personal inspection, close touch with the progress of the stations is maintained.

*Cooperation.*—The bureaus of this and other departments.

*Location.*—Washington, D. C.



*Date begun.*—1902.

*Assignment.*—Walter H. Evans.

*Proposed expenditures, 1918-19.*—\$4,124.

### **Alaska Experiment Stations:**

*Object.*—Development of agriculture, horticulture, and stock raising in Alaska.

*Procedure.*—This work is accomplished through agricultural surveys, the establishment and maintenance of experiment stations, and cooperative investigations to determine the best agricultural practices for Alaska and to aid in the development of agriculture in this Territory. Information regarding the results of the investigation is disseminated by means of bulletins, reports, and correspondence, and through demonstration work.

*Cooperation.*—The bureaus of this and other departments, experiment stations in various States and foreign countries, individuals, etc.

*Location.*—Headquarters, Sitka, Alaska; branch stations at Kodiak, Rampart, Fairbanks, and Matanuska.

*Date begun.*—1898.

*Results.*—On account of the wide range of climatic and soil conditions in various sections of Alaska, it has been necessary to locate stations in different parts of the Territory. The station last established, that located in the Matanuska Valley in the summer of 1917, is situated about 2 miles from the junction of the branch line from the Matanuska mines with the main line of the railroad which, when completed, will run from Seward to Fairbanks. Development work has been begun in Matanuska, which is in the center of an important homestead area with conditions believed to be very favorable to agriculture. A considerable amount of seed of acclimated grains and vegetables has been grown for cooperative and demonstration tests with farmers in various valleys, and the early reports from this work are quite satisfactory. As an emergency measure, it is intended to have the superintendent of the Fairbanks station visit all the important settlements to stimulate agricultural production on a larger scale. An experiment in the production of a dual-purpose strain of cattle has been begun at the Kodiak station, where six registered Holsteins were added to the Galloway herd in the summer of 1917. A report on the work of the stations for 1916 has been published.

The investigations carried on at the Alaska stations have indicated to some extent the types of agriculture that can be expected to succeed in the different parts of the Territory. Horticulture appears to be best adapted to the coast region, while grain production is apparently limited to the interior valleys. Plant-breeding experiments have yielded promising barley hybrids and hardy, productive strawberry hybrids with fruit of good size and quality. Some very striking improvements have also been made in varieties of oats and potatoes. Methods have been worked out for the proper handling of Alaskan soils, and revegetation experiments on Kodiak Island have yielded such excellent results that, where the soil is not too deeply covered with volcanic ash, production is better than before the eruption. The possibility of raising cattle and sheep on the pastures and locally produced feeds of the coast region has been demonstrated.

*Assignment.*—C. C. Georgeson, M. D. Snodgrass, G. W. Gasser, F. E. Rader, W. T. White, H. E. Pratt.

*Proposed expenditures, 1918-19.*—\$65,000.

### **Hawaii Experiment Station:**

*Object.*—To investigate the underlying principles of agriculture in Hawaii and to apply this knowledge to the diversification of agriculture in those islands.

*Procedure.*—Experiments are conducted with tropical crops to determine their adaptability to Hawaiian conditions, including the introduction of new and promising varieties of agricultural plants, forage production, plant-breeding work, study of the peculiar soils of Hawaii to determine proper methods of management, investigations of insects and other pests looking to methods of control, work in cooperative dairying, etc. The results are given publicity in bulletins and reports, correspondence, and through demonstration and extension work.

*Cooperation.*—The bureaus of this department, the War Department, private individuals, and the Territorial government of Hawaii.



*Location.*—Headquarters, Honolulu; branch and demonstration stations on other principal islands.

*Date begun.*—1901.

*Results.*—The emergency arising out of the war has enabled the station to extend the results of some of its investigations with great success. Spraying for the prevention of pineapple yellows has come to be widely practiced, and large areas of manganese soils have been planted to pineapples as a result of the station's work. Extensive potato spraying experiments have resulted in more than 50 per cent increase in that crop. Experiments in the drying and utilization of various food products have been conducted, and the resulting methods have been put in practice. The experimental work with rice, taro, potatoes, etc., has been given wide publicity through the extension division, the production of these important food plants having shown marked increase. The cooperative work with the War Department in the production of forage at Schofield Barracks is progressing, and a large number of varieties of introduced forage plants are being tested for adaptability. Under the direction of the station large quantities of sweet potatoes and other emergency foods have been produced by the soldiers at Schofield Barracks. Some new diseases of potatoes and bananas have been discovered, and experiments for their control are in progress. The following publications were issued during 1917-18; Bulletin 44, "The Litchi in Hawaii"; Press Bulletin 53, "Composition and Digestibility of Feeding Stuffs Grown in Hawaii"; Extension Bulletins—3, "Field Production of Beans"; 4, "Methods of Combating Garden Pests"; 5, "Peanuts—How to Grow and Use Them"; and 6, "The Banana as an Emergency Food Crop"; and the annual report for 1917.

Surveys of some of the principal soils have been concluded and suggestions for their management made. Range improvement has been studied, valuable forage plants introduced, and methods for increasing productivity worked out. The use of fertilizers for rice, as advised by the station, has proved profitable to many growers. The value of rotations, green manures, and cover crops has been demonstrated. New agricultural and horticultural crops adapted to Hawaii have been introduced and improved strains developed. At the Glenwood substation work is in progress with poultry, dairying, and vegetable growing. Demonstrations of the results of the station's investigations are being made on all of the larger islands.

*Assignment.*—J. M. Westgate, J. E. Higgins, F. G. Krauss, M. O. Johnson, C. W. Carpenter, C. A. Sahr, R. A. Goff.

*Proposed expenditures, 1918-19.*—\$45,000.

### **Porto Rico Experiment Station:**

*Object.*—To investigate the underlying principles of agriculture in Porto Rico and to apply this knowledge to the improvement of agricultural practices in that island.

*Procedure.*—Experiments are conducted with various tropical crops to determine their adaptability, including the introduction of new and improved varieties of agricultural and horticultural plants, work in plant breeding, studies in soil management, investigations in the control of insects and fungous pests, work in animal husbandry, and beekeeping. The results are given publicity by means of bulletins, reports, correspondence, extension work, and demonstrations.

*Cooperation.*—The bureaus of this department, the insular government, individuals, and corporations.

*Location.*—Headquarters, Mayaguez, P. R.; cooperative work at many places on the island.

*Date begun.*—1901.

*Results.*—Flattering success has been met with in the application of the results of the station's experiments in an attempt to increase the food production of the island. The largest corn crop in the history of the island has been produced, and the bean production has been so increased that Porto Rico is an exporter of that important food instead of a heavy importer. Investigations having indicated the possibility of successfully growing rice, extensive cooperative experiments have been begun in a number of places on the island to increase the local production of that crop, which is now chiefly imported. Important new crops have been



introduced, and their adoption is being rapidly extended. Work on the diseases of citrus fruits and bananas is being continued, and some new plant pests have been reported. Work on tick eradication has been begun, and the station farm is reported as having been cleared of ticks. Experiments have been completed on the relative availability of nitrate of soda and sulphate of ammonia for some important crops. The investigations of the causes of chlorosis of cane and its control are being continued. Publications issued during 1917-18 were: Bulletins—23, "The Changa or West Indian Mole Cricket," and 24, "The Mango in Porto Rico"; Circular 16, "Rearing Queen Bees in Porto Rico"; and the annual report for 1916. Manuscripts submitted for publication: "The Bat Guanos of Porto Rico and Their Fertilizing Value," "Some Means for Controlling Insects, Fungi, and Other Pests in Porto Rico," Spanish translation of Bulletin 19, "Cover Crops for Porto Rico," and the annual report for 1917.

Better methods of handling some of the peculiar soils have been discovered, improved varieties of coffee introduced, improvements in stock breeding and care brought about, the proper fertilizers for citrus orchards determined, the value of rotations and cover crops shown, beekeeping as an industry of the islands established, some work on sanitary dairying begun, and many new and improved agricultural and horticultural crops introduced. Investigations have shown the inadaptability of certain types of soil to coffee planting. As a result of experiments it has been found that varieties of vegetables do not deteriorate in the Tropics but that serious losses occur through diminished vitality of seed and planting in the wrong season. A method whereby the vitality of seed may be prolonged under Porto Rican conditions has been worked out.

*Assignment.*—D. W. May, P. L. Gile, W. V. Tower, N. C. Henricksen, W. A. Mace, T. B. McClelland, J. O. Carrero.

*Proposed expenditures, 1918-19.*—\$45,000.

#### **Guam Experiment Station:**

*Object.*—Determination of agricultural possibilities and improvement of agricultural practices in Guam.

*Procedure.*—Through a study of the agricultural and allied industries of Guam and the introduction and trial of crops and animals from other countries the station is making an attempt to restore and improve the agriculture of the island. The results of the investigations are given in publications and are shown in demonstration experiments.

*Cooperation.*—The bureaus of this department and the island government.

*Location.*—Island of Guam.

*Date begun.*—1908.

*Results.*—The continued success with cotton seems to indicate that the growing of this crop can be made profitable in Guam. Great improvement has been brought about in the quality and yield of corn. The value of arsenical dips for the control of cattle ticks has been demonstrated. The stock-breeding work continues to give promising results, and that with pigs, goats, and poultry is being rapidly extended. A hybrid race of chickens has been produced that seems to be less subject to disease than introduced breeds and to have a higher egg production than native strains. Experiments with locally produced feeds are in progress. The report of the station for 1917 has been published.

Through the introduction and establishment of various forage plants permanent supplies of forage are made possible, and the improvement of the live stock of the island has been begun. Improved breeds of horses, cattle, goats, swine, and poultry have been introduced, acclimated, and are being used to build up better live stock. Some of the agricultural and horticultural crops brought from other countries have proved superior to varieties now grown on the island and are well received by the people. Studies are in progress on animal diseases peculiar to the Tropics with results that promise to be of value.

*Assignment.*—C. W. Edwards, Glen Briggs, P. Nelson.

*Proposed expenditures, 1918-19.*—\$20,000.

#### **Virgin Islands Experiment Station:**

*Object.*—To investigate the agriculture of the Virgin Islands of the United States and to determine its possibilities and means for its improvement.



*Procedure.*—A study will be made of the agriculture and allied industries of the islands, and the work that has been in progress on sugar cane, cotton, and forage crops will be continued and extended. Improved varieties of agricultural and horticultural crops will be sought; soil-management and irrigation studies undertaken; and live-stock breeding, dairying, etc., inaugurated. The results of the experiments will be made available through publications and through demonstrations conducted on the different islands of the group.

*Cooperation.*—The bureaus of this department, the local government, and individuals.

*Location.*—Island of St. Croix.

*Date begun.*—July 1, 1918.

*Assignment.*—Walter H. Evans, Longfield Smith.

*Proposed expenditures, 1918-19.*—\$15,000.

**Total, Insular Experiment Stations, \$194,124, including \$1,880 statutory.**

**Total, Relations with Experiment Stations, \$242,940, including \$14,440 statutory (research, \$194,124; regulation, \$48,816).**

#### [Regulation.]

### RELATIONS WITH EXTENSION DIVISIONS OF STATE AGRICULTURAL COLLEGES.

#### Relations with Extension Divisions of State Agricultural Colleges:

*Object.*—To administer the provisions of the act approved May 8, 1914, providing for cooperative agricultural extension work; to enable the Secretary of Agriculture to certify to the Treasury Department whether Federal funds may properly be advanced to the State agricultural colleges, and to report to Congress regarding the work and expenditures of the extension divisions of these institutions; and to coordinate the work of the department with that conducted by the State agricultural colleges along the lines authorized in said act.

*Procedure.*—A financial report on schedules approved by the Secretary of Agriculture is received from each extension division and examined and approved in this office. Written and printed reports of the work and expenditures of each extension division are received and examined. A personal inspection of the work, account books, and vouchers of each division is made annually. On the basis of the information gained from the aforesaid sources a report on the work and expenditures of each extension division is made annually to Congress and distributed in this and other countries. The plans for work under the act of May 8, 1914, are reported by each extension division to this office and approved here in advance of their execution. Projects involving cooperative extension work between the bureaus of the Department of Agriculture and the State agricultural colleges are also considered and approved in this office.

*Cooperation.*—State agricultural colleges in 48 States.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Assignment.*—Bradford Knapp, J. A. Evans, H. E. Savely, W. B. Mercier, E. A. Miller, C. B. Smith, L. A. Clinton, D. W. Working, R. W. Redman.

*Proposed expenditures, 1918-19.*—\$34,200, including \$4,200 statutory.

#### [Extension.]

### FARMERS' COOPERATIVE DEMONSTRATIONS IN THE SOUTHERN STATES.

#### Supervision:

*Object.*—To carry on supervisory, clerical, and routine work necessary to properly conduct the demonstration work in the 15 Southern States.

*Cooperation.*—Other bureaus of the department, State agricultural colleges, counties, and county organizations.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Assignment.*—Bradford Knapp, J. A. Evans.

*Proposed expenditures, 1918-19.*—\$44,620.



**County-Agent and Boys' Club Work:**

*Object.*—To disseminate information from the Department of Agriculture and the agricultural colleges on subjects relating to agriculture; to secure the adoption of the practices recommended by conducting demonstrations on farms; to organize a system of instruction through practical field demonstrations and otherwise by employing and directing the work of county agricultural agents or demonstration agents; to carry out information from the department collected by the research work of its several divisions, by establishing contact between the research divisions of the department and the cooperative extension work in the States through the States Relations Service, State directors of extension work, and State, district, and county agents engaged in demonstration work; to give instruction to boys through the organization and work of boys' clubs, such as corn clubs, pig clubs, potato clubs, etc.; and to assist in bringing to the State, district, and county agents, through the State extension officers, the best systems of conducting the county-agent work and the boys' club work. In this work is also included the teaching and demonstration of the best methods of meeting the ravages of the Mexican cotton boll weevil in all cotton territory.

*Procedure.*—In each State there is a director of extension work, who is a representative of the United States Department of Agriculture and the agricultural college of the State concerned. Under the terms of the project agreements with each State, he is made responsible to the department and to the college for the faithful administration of the work. Under him there is generally a State agent or leader, district agents, county agents, and also specialists. All the work is in cooperation with the State agricultural college in each State. The county agents organize and conduct general demonstration and extension work in their counties. The main feature of their work is the conducting of a large number of actual demonstrations along various agricultural lines on the farms in the county in cooperation with farmers, which are made object lessons for the teaching of better agricultural practices to these farmers and their neighbors. County agents also give miscellaneous information to farmers on all agricultural subjects upon application, conduct meetings and field schools at the demonstrations, and organize and conduct such meetings, institutes, or short courses as may be necessary for the further extension of their work. They also foster the development of community organizations for the purpose of receiving instruction, through demonstrations and otherwise, and endeavor in every way to build up and organize a system of education outside the schools. Often the community organizations of the farmers and their families are federated together into some type of county organization. They are aided in their work of teaching through demonstrations and otherwise and in organization by specialists from the agricultural colleges and from the department. They also organize, in cooperation with the schools, boys' agricultural clubs for various purposes and cooperate with specialists and others in their instruction. Extension divisions in the States and extension specialists are assisted in their work by specialists from the department, who furnish them with technical instruction obtained from research divisions of the department and with special information on methods of conducting demonstration and extension work through employees of the Office of Extension Work in the South of this bureau.

*Cooperation.*—State agricultural colleges, other State institutions, counties, and county organizations.

*Location.*—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

*Date begun.*—1904.

*Results.*—The work of the agents was much more far-reaching than the statement herein would indicate, inasmuch as a very great number of farmers were reached and influenced by them in various ways in addition to the actual demonstrations. A partial result of their work during the crop season of 1917 shows 346,136 demonstrations, as follows: 501,729 acres in cotton, 799,476 acres in corn, 5,009 acres in tobacco, 159,578 acres in oats, 156,660 acres in wheat, 68,769 acres in rye, 2,490 acres in barley, 44,526 acres in alfalfa, 37,117 acres in crimson clover, 17,392 acres in red clover, 2,187 acres in bur clover, 14,058 acres in sweet



clover, 11,343 acres in sudan grass, 125,510 acres in other miscellaneous forage crops, 157,134 acres in cowpeas, 78,397 acres in soy beans, 540,448 acres in velvet beans, 100,505 acres in peanuts, 14,089 acres in Irish potatoes, and 11,178 acres in sweet potatoes. There were 5,061 demonstrations in home orchards comprising 635,864 trees, and 37,017 orchards were inspected, pruned, sprayed, wormed, and planted through demonstration influences. Through the influence of agents and specialists pure-blood animals were brought into the various States, as follows: 3,711 horses and mules, 12,663 dairy cattle, 18,598 beef cattle, 48,931 hogs, and 4,516 sheep and goats. About 5,368 poultry demonstrations were conducted. Farmers were induced to treat 3,297,272 animals for diseases and pests, including 742,939 hogs treated for cholera; 2,256 dipping vats and 5,517 silos were built; 56,031 farmers were instructed in the care of manure, approximately 6,288,385 tons being saved; and 25,068 farmers were induced to use 233,860 tons of lime; 3,507 community or farmers' clubs were organized, with a total membership of 113,316. The agents advised 156,804 farmers regarding the proper use of fertilizers, the total amount used being 53,686 tons; 2,508 communities bought fertilizers cooperatively at a value of \$1,351,910 and at a saving of \$194,789. Home mixing of fertilizers was practiced by 33,508 farmers. The agents instructed farmers in the erection of 6,413 buildings, the improvement of 8,795 buildings, the installation of 1,753 home water systems and 3,012 home lighting systems, the screening of 33,720 homes, the installation of 8,165 flytraps, the erection of 7,420 sanitary privies, and the installation of 1,998 telephone systems; 12,135 new pastures were established, 6,303 old pastures renovated, 643,881 acres drained, 420,322 acres terraced, 86,756 acres cleared of stumps, and 315,654 home gardens planted or improved; 388,708 farmers were induced to save surplus farm products for winter use; assistance was given in 1,174 road-improving demonstrations and 103,803 new implements and tools were bought. Agents made 885,966 visits to farmers and others interested, and 765,207 farmers called at the agents' offices. The agents traveled 5,757,450 miles, and 46,172 meetings were held, with a total attendance of 3,676,590. There was a total enrollment of 115,745 members in boys' agricultural clubs. The field work was carried on by 29 directors and State agents, 24 assistant State agents and supervisors of boys' club work, 12 specialists (including three boll-weevil specialists in Alabama and two in Georgia), 55 district agents, 31 county agents, boys' club work. 860 county agents, 28 assistant county agents, and 66 local agents.

*Assignment.*—Bradford Knapp, J. A. Evans, W. B. Mercier, H. E. Savely, E. A. Miller, I. W. Hill.

*Proposed expenditures, 1918-19.*—\$497,400.

(See also Supplement—Emergency Activities, p. 567.)

### **Home-Demonstration Work, Including Girls' Club Work:**

*Object.*—To organize and carry on extension work for women and girls by employing and directing the work of women county agents, for the purpose of disseminating information and conducting demonstrations with farm women in the homes in the rural sections of the South and instructing girls in home economics and kindred subjects; to carry out information from the United States Department of Agriculture and State colleges on subjects relating to home economics and allied subjects; also to disseminate information on methods of conducting home-demonstration work and extension work for women to extension workers in the various States.

*Procedure.*—In cooperation with various institutions in the South, women county agents are employed, part of whose salaries are paid by the counties and part from funds of the colleges and the department. They conduct demonstrations in home gardens and poultry, organize women's clubs for demonstration and study, and give general instruction in home economics; organize girls' clubs in the teaching of gardening and canning and other subjects, carry on the general work of extension in home economics, and, in general, proceed with their work in practically the same manner as do the men county agents, the work of the women county agents and that of the county agricultural agents being coordinated as closely as possible. In addition to specialists from the agricultural



colleges, specialists from the Department of Agriculture give assistance in the instruction of farm women and girls and in the training and instruction of extension workers in this division of the work.

*Cooperation.*—State agricultural colleges, women's colleges, and local organizations.

*Location.*—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

*Date begun.*—1911.

*Results.*—In 1917 demonstration work for girls and women was conducted in 715 counties, with 513 women agents, who gave instruction to 61,589 girls and 82,227 women. Each of the girls produced a one-tenth acre home garden of tomatoes or tomatoes and other vegetables. They put up 8,882,738 containers from their one-tenth-acre plots and 3,961,775 other containers from the farm and orchard. The total value of these 12,844,513 containers was \$2,493,414.68. During the same period the women put up 34,993,677 containers, valued at \$7,042,137.63; making the total number of containers for the women and girls 47,838,190, having a total value of \$9,535,552.31. There were 44,146 caps and aprons and 5,919 dresses made by the girls. Instruction was also given in the raising of poultry, marketing of eggs, making of butter, keeping of milk, preparation of food for the table, baking bread, etc. In the poultry clubs there were 11,717 girls enrolled; 12,914 girls made cooking demonstrations, and 7,079 made bread demonstrations. In the work for adult women special attention was given to labor-saving devices, the number of devices made or purchased by these women being as follows: Fireless cookers, 4,704; iceless refrigerators, 3,341; flytraps, 7,586; wheel trays, 399; kitchen cabinets, 920; ironing boards, 759; driers or evaporators, 2,249; water systems installed, 1,000; shower baths installed, 79; houses screened, 6,277; and miscellaneous articles, 9,452. The number of devices made or purchased in the butter work was 4,718, and the total number of pounds of butter made under demonstration methods was 83,568. There were 10,633 winter gardens started, 75 rest rooms installed, and 103 egg circles and 39 cooperative breeding associations organized. The field work was carried on by 13 State agents and leaders, 16 assistant State agents or leaders and assistants, 8 specialists, 17 district agents, 513 county agents, and 7 local agents.

*Assignment.*—Bradford Knapp, O. B. Martin, Mary E. Creswell, Ola Powell.

*Proposed expenditures, 1918-19.*—\$144,480.

(See also Supplement—Emergency Activities, p. 567.)

**Total, Farmers' Cooperative Demonstrations in the Southern States,**  
\$686,500, including \$36,360 statutory.

[Extension.]

**FARMERS' COOPERATIVE DEMONSTRATIONS IN THE NORTHERN  
AND WESTERN STATES.**

**Supervision:**

*Object.*—To carry on supervisory, clerical, and routine work necessary to conduct properly the demonstration work in the 33 Northern and Western States.

*Cooperation.*—Other bureaus of the department, State agricultural colleges, counties, and county organizations.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Assignment.*—C. B. Smith, L. A. Clinton.

*Proposed expenditures, 1918-19.*—\$31,020.

**County-Agent Work:**

*Object.*—To give instruction and demonstrations in agriculture, in order to secure the adoption of better farm practice, organization, and administration, to the end of increasing the profits of farming and improving social life.

*Procedure.*—In each State there is a director of extension work, who is the joint representative of the State agricultural college and the department and is in administrative control of all the cooperative agricultural exten-



sion work in the State. For the purposes of this project, under the director is a State leader of county agents, chosen under a cooperative agreement between the college and the department and representing both parties. Subject to the approval of the college and the department, the State leader enters into agreements with boards of county commissioners and local associations to finance and otherwise support the work of a county agricultural agent and to select a suitable agent, who works thereafter under the direct supervision of the county-agent leader. In each county in which an agent is appointed there is usually organized an association of farmers, known as a county farm bureau, through which the agent projects his work and which cooperates with him in determining lines of work to be undertaken. The county agents, who are men well trained in the science of agriculture and familiar with farm practice, are located permanently in counties (with or without assistants) as rapidly as circumstances warrant and funds permit. They coordinate and apply the results of the work of the several departments of the State agricultural colleges and of the United States Department of Agriculture and other research institutions, as well as the results of their own local studies of farm practice, to the end of carrying concretely to the farmers, through demonstrations on their own farms, field meetings, the local press, and otherwise, a knowledge of sound principles and successful practices in agriculture. They also aid in the reorganization and redirection of the agriculture of the counties in which they work, their aim being the correlation and federation of all economic and social forces working for the improvement of agriculture and country life. As occasion offers or need arises they cooperate with or organize agricultural societies, clubs, and other associations whose objects are the improvement of agricultural practices, marketing and purchasing methods and facilities, and educational, home, and social conditions throughout the counties in which they work. Farmers and members of their families are met individually for consultation and in groups for purposes of study, instruction, and demonstration in the school, creamery, barn, orchard, or field. As far as possible, the work of the county agent is developed in accordance with written projects approved by the executive committee of the county farm bureau and the extension division of the agricultural college.

*Cooperation.*—State agricultural colleges, county boards of commissioners, county farm bureaus, farmers' clubs, and other local organizations.

*Location.*—Throughout the 33 Northern and Western States.

*Date begun.*—1912.

*Results.*—Among the outstanding results accomplished during the past year are the following: Assistance was given to 132,028 farmers in securing or locating 2,666,296 bushels of seed grain and seed potatoes, including more than half a million bushels of seed corn for the 1918 crop. As a direct result of crop-production campaigns which the agents directed or helped to conduct, 3,478,982 additional acres are reported to have been sown or planted, thereby increasing crop production 32,767,991 bushels and forage 271,862 tons. The number of farm laborers placed aggregated 66,036. The county agents conducted 34,613 demonstrations, involving 2,084,589 acres of crops and 149,820 head of live stock; and held 13,047 demonstration meetings to acquaint farmers with results, attended by more than 400,000 persons. On 16,370 demonstrations where data were gathered the agents report nearly four and a half million dollars profit to farmers, due to increased production or saving resulting from following methods recommended; 56,599 farmers cooperated with the agents in treating seed oats for smut, resulting in 1,162,194 additional acres of oats being sown with treated seed; 23,306 farmers were encouraged to select or treat their seed potatoes for the control of scab and other potato diseases, resulting in nearly 97,526 additional acres being planted with treated seed. Considerable time was spent in helping to stimulate the raising of more legumes, both for forage, seed, and soil improvement, resulting in the sowing of 77,755 additional acres of alfalfa, 26,990 acres of sweet clover, 66,854 acres of soy beans, 8,798 acres of cowpeas, and 10,097 acres of vetch. Assistance was given in organizing 160 live-stock breeders' associations and 182 cow-testing associations; 151,394 cows were under test, resulting in 8,724 cows being discarded as unprofitable. Primarily through these organizations 10,986 farmers were induced to adopt balanced rations for their herds, and the following number of head of registered stock were



secured at the suggestion of agents: Bulls, 3,285; cows, 4,836; rams, 1,469; and boars, 2,974; 197,508 animals were vaccinated for blackleg, and 235,866 hogs were vaccinated for cholera by the agents or by farmers or veterinarians at the suggestion of the agents; and 36,392 animals, principally cows, were tested for tuberculosis. The agents tested soil for acidity on 11,163 farms, brought about the development of 301 local sources of marl or other forms of lime, and helped to have 64 limestone crushers introduced. The county agents arranged for 7,631 canning demonstrations for women, aside from club work, resulting in 4,684,423 additional quarts of fruit and vegetables being canned. Assistance in home gardening was given to 160,163 persons, while 82,434 farmers were given information in regard to the best methods of storing fruit and vegetables. Through the 637 farmers' exchanges and other cooperative purchasing and marketing associations organized with the assistance of agents or at their suggestion, \$18,405,478 worth of farm products and farm supplies were handled, resulting in saving nearly \$1,500,000. In doing the above work the county agents personally visited 157,683 different farmers, gave information to 468,514 callers at their offices, and took part in 55,432 meetings, attended by more than 3,059,387 persons; and 747,916 letters were written giving information. They also sent out 3,062,218 circulars and circular letters. Three hundred and eighty-four of the counties having agents had farm bureaus, with 161,391 members, on December 1, 1917. Since the work was inaugurated the number of agents has increased from 4, on June 30, 1912, to 542, on June 30, 1917, at which time there was a county-agent leader in each of the 33 Northern and Western States and 22 assistant county-agent leaders.

*Assignment.*—W. A. Lloyd, H. B. Fuller, H. W. Gilbertson, L. R. Simons, O. S. Fisher.

*Proposed expenditures, 1918-19.*—\$318,300.

(See also Supplement—Emergency Activities. p. 568.)

### **Boys' and Girls' Club Work:**

*Object.*—To interest boys and girls and, through them, adults, in practical **farm, home, and rural community** problems; to teach them better methods of farming, gardening, poultry and animal husbandry, and home practice; to offer them leadership and definite instruction from the Department of Agriculture, working in cooperation with the colleges of agriculture and the public schools, and to encourage them as far as possible to secure a practical education in agriculture and home economics, with a view to make them successful workers, home makers, and citizens.

*Procedure.*—The extension work for boys and girls is organized and supervised by a State leader in charge, with assistants, specialists, and district and county leaders, their work being supplemented by that of volunteer local leaders trained for the local leadership of the boys' and girls' club work. All the work is carried on in cooperation with farm bureaus, county agricultural agents, and schools. It is based on the organizing of young people into local groups who undertake definite agricultural and home-economic projects. The work contemplates the definite enrollment of members, organizing them into local clubs, selecting either a volunteer or paid local leader to have charge of each club group, furnishing them with follow-up instructions, making personal visits to plats and club groups, and holding field meetings and demonstrations for instructional purposes; keeping records of observations, expenses, and receipts; making exhibits of products; studying improved methods of grading, crating, and marketing; promoting the conservation, through home canning, of the surplus or by-products; holding club fairs and festivals, and giving instruction as to how club work may be correlated and coordinated with the activities of the home as well as the public schools. The club projects are corn, potato, alfalfa, forage, sugar beet, poultry, pig, baby beef, market gardening, farm and home handicraft, home management, farm management, sewing, bread making, and garment making.

*Cooperation.*—State agricultural colleges, school officers, teachers, women's clubs, and other organizations.

*Location.*—Throughout the 33 Northern and Western States.

*Date begun.*—1912.

*Results.*—During the calendar year ending December 31, 1917, there were 395 paid cooperative leaders in the boys' and girls' club work, employed chiefly on part time, and 52,000 volunteer leaders working under the



instructions of the paid leaders. Over half of the paid leaders were employed by local people at local expense, but their work was articulated with the extension work of the State. About 1,150 counties in the Northern and Western States are organized for boys' and girls' extension work; 440,606 boys and girls were regularly enrolled in club work, and 400,000 city boys and girls were enlisted in the war-garden project. From data submitted it is believed that 82 per cent of all who started the work actually produced food and did most of the work required in the project, while 53 per cent of the enrollment finished the work in the project and made complete and authenticated reports. The value of food products produced by members completing their projects was reported as \$3,681,329.49. The production cost was reported as \$1,288,675.33, including a charge for the labor of boys and girls at the rate of 10 cents per hour. The overhead and supervisory cost of the work from all sources totaled \$329,935.29. The average cost per club member for 12 months, based upon the total enrollment and the total cost of overhead supervision, was 74 cents. The average value of food production produced by those reporting was \$21.89.

*Assignment.*—O. H. Benson, G. E. Farrell, T. J. Newbill, Gertrude L. Warren.

*Proposed expenditures, 1918-19.*—\$126,380.

(See also Supplement—Emergency Activities, p. 568.)

### **Farm-Management Demonstrations:**

*Object.*—To demonstrate to farmers, in connection with their own farms, a practical method of recording, summarizing, and analyzing the farm business; to demonstrate to farmers the importance of an efficient organization and administration of the farm business; to increase the effectiveness of county-agent work.

*Procedure.*—Farm-management demonstrators are placed in each State to assist county agricultural agents or other local leaders to conduct farm-management demonstrations in the following manner: (1) Upon request of the county agent, an extended and thorough campaign is carried on to impress upon farmers within the county the importance and ease of keeping farm accounts and of summarizing and analyzing them at the end of the year. (2) A group of farmers so located meet together and are assisted in starting an account with the farm business for the current year. This includes entering the inventory and bringing the record up to date. (3) Interested individuals in such a group are assisted in making a farm-analysis record of their business of the preceding year, in summarizing their records to find how profitable the business has been, and in arranging the information secured for easy comparison with the business of the current year. (4) Cooperating farmers are given assistance throughout the year either by follow-up letters, personal visits, or group meetings. At the end of the year they are aided, so far as may be necessary, in summarizing and analyzing their records as a basis for making decisions with reference to modifying the organization and administration of the farm which promise to increase the net income. (5) After the county agent has become familiar with this work he is assisted in bringing it to the attention of other farmers and their families by means of a well-defined campaign and helping those who desire to study their own farm business in a similar manner.

*Cooperation.*—State agricultural colleges.

*Location.*—Throughout the 33 Northern and Western States.

*Date begun.*—1914.

*Results.*—During the past year considerable emphasis has been given to the importance and ease of keeping simple farm accounts. Up to the present time more than 30,000 farmers have been assisted by county agricultural agents and farm-management demonstrators in starting simple farm records. Over 3,000 farmers are reported as having successfully kept such accounts during the year. More than 5,000 farmers have used simple farm accounts as a basis for strengthening their business in succeeding years. Many farmers have continued giving farm-analysis records. Nearly 25,000 farmers in 342 counties and 27 States have been assisted along this line.

Prior to the fall of 1917 most of the work was done with individuals. Since then the demand has grown to such an extent that the more progressive leaders are working with groups of interested farmers only. A



great deal of attention is being given at the present time to the more efficient use of available labor, better planning of farm enterprises, and more efficient production.

*Assignment.*—L. H. Goddard, P. K. Whelpton, F. A. Roper.

*Proposed expenditures, 1918-19.*—\$63,400.

### Extension Work in Home Economics:

*Object.*—To organize, correlate, and conduct extension work in home economics with farm women for the purpose of securing efficiency and promoting prosperity and contentment in the farm home.

*Procedure.*—Women trained in home economics, and known as home-demonstration agents, are cooperatively employed by the United States Department of Agriculture, the State colleges of agriculture, and individual counties, who devote their entire time to the organization and development of the home interests of the county in which they are respectively located and give instruction through demonstrations and otherwise in such subjects as food values and the selection, preservation, preparation, and serving of foods; the making, care, and laundering of garments; house arrangement, equipment, and furnishings; sanitation, including water supply and sewage disposal; heat, ventilation, light, and insect control; and in the organization of women into groups where such organization is needed for the study of home and related problems. The special subjects selected for instruction and demonstration are determined by the apparent needs of each community and by the willingness of the local people to cooperate. Assistance is given to the home-economics departments of the agricultural colleges in developing their home-economics extension work through movable schools and other work done by the home-economics specialists with headquarters at the college.

*Cooperation.*—Other bureaus of the department, State agricultural colleges, counties, and local organizations.

*Location.*—Throughout the 33 Northern and Western States.

*Date begun.*—1916.

*Results.*—Six State leaders, 21 county home-demonstration agents, and 2 district home-demonstration agents are cooperatively employed. The following examples indicate the nature of the work conducted in counties where home-demonstration agents had been installed: In Arizona home-demonstration agents demonstrated the possibility of grinding the milo maize grown in certain arid districts of the State in hand mills and using the flour as a wheat substitute. The manufacture of this flour has now been undertaken by commercial interests. This market will prove a new source of income for farmers in these districts and will open up about 30,000 acres of arid land for a profitable cash crop. The value of fruits and vegetables canned in New Mexico as a result of the home-demonstration agent work was \$44,060.50. In Montana the value of the fruits and vegetables canned in the past summer in 8 counties under the direction of permanent and emergency home-demonstration agents was \$83,343. Nebraska had 5 community drying plants and dried 15,000 bushels in addition to canning great quantities of fruit and vegetables. Black Hawk County, Iowa, estimates the monthly saving made possible by demonstrations given by the home-demonstration agent as 469,000 pounds of wheat, 155,000 pounds of meat, 112,000 pounds of sugar, and 75,000 pounds of fat. Worcester County, Mass., canned 579,912 quarts of fruits and vegetables. Hampden County, in the same State, canned 450,000 quarts, at an estimated value of \$192,000. Through the efforts of the home-demonstration agents thousands of pounds of jam and fruit have been shipped to France. Agents have organized clubs which are remodeling old clothes into uniform garments for the Belgian refugees. The women in one county in Connecticut put up 7 tons of jams and jellies which were shipped to France; and 25 community canning kitchens were established, largely under the direction of the permanent home-demonstration agents, in this State.

*Assignment.*—Florence E. Ward, Miriam Birdseye, Margaret Hooker, Edith C. Salisbury, Marie Sayles, Marie Sellers, Ruby G. Smith, Edna Thomas.

*Proposed expenditures, 1918-19.*—\$40,800.

(See also Supplement—Emergency Activities, p. 568.)

### Extension Work through Special Field Agents:

*Object.*—(1) To establish and perfect a system of cooperation between the subject-matter bureaus and the States Relations Service of the United



States Department of Agriculture and the extension divisions of the State agricultural colleges of the 33 Northern and Western States, in accordance with the general memorandum of understanding now in force with each State, in order that the information developed by the subject-matter bureaus may be carried to the public through extension agencies; (2) to study methods of agricultural extension teaching in effect in the various States, and to carry the good results of such methods from one State to another; (3) to facilitate the work of the various bureaus in their co-operative relations with the extension divisions, and to enable their field workers to do their work more effectively; (4) to advise with the States Relations Service on technical matters affecting extension work in agricultural subjects, and to aid the extension divisions in organizing their subject-matter extension work throughout the State.

*Procedure.*—The work will be carried on in the various States through project agreements for cooperative subject-matter extension work and in accordance with the general memorandum of understanding. The extension representative of each subject-matter bureau, division, or service will assist the State divisions of extension in instituting the best methods of procedure, in cooperation with the director of extension in the States. He will keep himself informed and report in writing regarding the progress of the work in the subject-matter projects coming within the province of the bureau, division, or service represented by him, as carried on in the 33 Northern and Western States with Smith-Lever or department funds. Through the extension field agents arrangements may be made from time to time to send other subject-matter representatives of the United States Department of Agriculture into the States for short campaigns in connection with subject-matter work contemplated, but this will be done only after proper arrangements have been made with the extension division of the State where such campaign is to be carried on.

*Cooperation.*—Other bureaus of the department and State agricultural colleges.

*Location.*—Washington, D. C., and throughout the 33 Northern and Western States.

*Date begun.*—1916.

*Assignment.*—A. B. Graham, H. J. Wilder, A. F. Hawes, J. W. Kinghorne, C. P. Close, Helmer Rabild.

*Proposed expenditures, 1918-19.*—\$14,980.

**Total, Farmers' Cooperative Demonstrations in the Northern and Western States, \$594,880, including \$40,080 statutory.**

#### [Research.]

### FARMERS' INSTITUTES AND AGRICULTURAL SCHOOLS.

#### Farmers' Institutes and Movable Schools:

*Object.*—To study the work of farmers' institutes, movable schools, and similar organizations, as carried on in this and other countries, especially with a view to devise and experiment with modified or new methods adapted to conditions in the United States; and to provide farmers' institute and extension workers with publications especially adapted to their needs.

*Procedure.*—Reports of the farmers' institutes, movable schools, and similar agencies at home and abroad are collected and studied, and an annual report is made on these. Syllabi and lantern slides for lectures at farmers' meetings are prepared and distributed. Courses of study for movable schools and other material for use in extension work are prepared.

*Cooperation.*—Other bureaus of the department, which furnish the subject matter for the syllabi and courses.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Results.*—The demand for syllabi for lectures accompanied with lantern slides has continued as heretofore. Ten additional syllabi, each accompanied with 50 lantern slides, have been published as follows: No. 24, "Leguminous Forage Crops for the South"; No. 25, "Leguminous Forage Crops for the North"; No. 26, "Sweet Potatoes: Culture and Storage"; No. 27, "The Farm Vegetable Garden"; No. 28, "Practical



Improvement of Farm Grounds"; No. 29, "Public-Road Improvement"; No. 30, "Cow Testing and Dairy Records"; No. 31, "Renovating the Neglected Apple Orchard"; No. 32, "The Growing and Handling of Irish Potatoes"; and No. 33, "The City and Suburban Vegetable Garden." It has been demonstrated that the reports of farmers' institutes and syllabi for lectures accompanied with lantern slides have been useful to all classes of extension workers, including county agricultural agents, farmers' institute lecturers, extension teachers in agricultural colleges and agricultural high schools, grange lecturers, rural school superintendents, rural sanitary officers, rural preachers, etc.

*Assignment.*—J. M. Stedman.

*Proposed expenditures, 1918-19.*—\$6,200.

### **Investigations of Agricultural Instruction in Schools:**

*Object.*—To study the methods and subject matter of school instruction in agriculture in this and other countries, with a view to determine the needs of such instruction, in order to make it practically useful to students who are to become farmers or workers in agricultural institutions; and to furnish schools with up-to-date and properly organized subject matter and illustrative materials to supplement and reenforce textbooks and field practice.

*Procedure.*—Schools are visited and conferences held with school officers and teachers, professors of agricultural education, etc. Reports and catalogues and other publications of agricultural schools at home and abroad are collected and studied. Publications outlining courses of study and lessons, as well as practical exercises, are prepared; also lantern slides, charts, and other illustrative material especially adapted to school use.

*Cooperation.*—Other bureaus of the department, Bureau of Education, Federal Board for Vocational Education, State agricultural colleges and schools, and school officers.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Results.*—During the past year two bulletins for secondary-school teachers of agriculture have been published—Department Bulletin 592, "Courses in Secondary Agriculture for Southern Schools (Third and Fourth Years)," and Department Bulletin 593, "Judging Sheep as a Subject of Instruction in Secondary Schools." Eleven other documents containing suggestions for instruction on different agricultural subjects in secondary schools have been printed. A bulletin on the home project as a phase of vocational agricultural education has been prepared at the request of the Federal Board for Vocational Education. For elementary-school agriculture, Department Bulletin 646, "Lessons on Pork Production for Rural Elementary Schools," has been issued, and a revision of Farmers' Bulletin 617 has been issued as Department Bulletin 653, "Lessons on Corn for Rural Elementary Schools." A manuscript has been prepared for a similar bulletin on "Lessons on Dairying for Rural Schools." Ten leaflets on the use of Farmers' Bulletins in elementary schools have been prepared. The classified lists of publications, lists of references, sources of material, etc., have been increased in number and have been frequently revised.

The office has prepared lantern-slide sets with lecture syllabi on "How to Teach Poultry Lessons," "Sheep Judging and Breeds of Sheep," and "Tomato Growing," and three sets on phases of instruction in garden practice. Sets which were previously in use are being revised and lecture syllabi prepared for those which have none. Plans have been developed by means of which illustrative material of various types may be made more available to schools in the several States. The literature on agricultural education continues to be abstracted for the Experiment Station Record.

A manuscript has been prepared, in cooperation with the State Department of Education and the State College of Agriculture of Ohio, for a "Manual of Agriculture for the Elementary Schools of Ohio." A similar cooperative work has recently been published by the State Department of Education of Virginia.

In cooperation with the Bureau of Education, manuscripts on vocational agricultural education in the secondary schools of six Northeastern States and on a survey of two counties in Texas have been prepared.



Cooperation with the Association of American Agricultural Colleges and Experiment Stations has been continued. The work now under way consists of the collection of data on war-emergency courses conducted by the agricultural colleges.

*Assignment.*—F. E. Heald, Alvin Dille.

*Proposed expenditures, 1918-19.*—\$19,740.

**Total, Farmers' Institutes and Agricultural Schools, \$25,940, including \$5,340 statutory.**

[Research.]

## HOME-ECONOMICS INVESTIGATIONS.

### Studies of Food, Dietetics, Clothing, and Household Equipment, Work, and Management:

*Object.*—To study the nature of agricultural products used in the home for food, clothing, and equipment; to study household processes, methods, and uses pertaining thereto; to classify, compare, revise, and digest information useful to extension workers, housekeepers, teachers, and students, and to make available for their needs the results of research; and to conduct research on the digestibility of agricultural products used for food purposes with respect both to food materials already in common use and new food materials produced in the United States and its insular possessions.

*Procedure.*—A systematic study is made, by general and special research methods, of the nature and uses of foods, clothing, household textiles, and other household supplies. The results of research in home economics are disseminated through publications and by other means. The thoroughness of the digestion of different foods, the influence of methods of preparation upon digestibility, and other related problems are being investigated.

*Cooperation.*—Other bureaus of the department and other departments.

*Location.*—Washington, D. C.

*Date begun.*—1894, as regards food; 1913, as regards studies of the utilization of foods by the body; 1914, as regards clothing, household equipment, and household management.

*Results.*—Much information, both general and specific, has been brought together and distributed by means of technical and popular bulletins and in other ways, which helps the housekeeper to understand her materials and to use them to good advantage, and which is also of value as a basis for extension and other teaching in home economics. During the year special attention has been given to war-emergency problems and especially those which have to do with the selection and preparation of food, planning of meals, and related topics, with a view to help the housekeeper to make the most and best use of available resources. Emergency household practices, the avoidance of waste, household thrift, and economical procedures have been studied and practical deductions drawn from technical and other experimental work and discussed in nontechnical terms and in such a way that the housekeeper may be helped to meet the war-emergency situation. An extended series of experiments on the influence of different household methods of canning upon the keeping and other qualities of different products was completed and a bulletin prepared. Studies of the canning of meat and fish have also been completed, and the results are being embodied in a report. Special features of the work have been a dietary survey in American homes, in cooperation with the Bureau of Markets, and the establishment of an experimental kitchen for the study of war-cookery problems. There has also been cooperation with the Food Administration and the Bureau of Education in the preparation of a series of outlines of food conservation courses for colleges. The work with clothing, textiles, and household equipment has been continued, with the result that in addition to some publicity material three bulletins have been prepared for publication, as follows: "Floors and Floor Coverings," "Clothing Materials and Their Care—I, Cotton and Linen," and "Clothing Materials and Their Care—II, Wool, Silk and Artificial Silk." During the year the following miscellaneous circulars were issued: "Guide to the Nation's Dietary," "Household Waste and Ways to Avoid It," and "The American Papaw and Its Food Value"; in cooperation with the Food Administration and the Bureau of Education,



"Ten Lessons on Food Conservation"; in cooperation with the Bureau of Labor, "Cost of Living in the District of Columbia: Feeding the Family"; also Farmers' Bulletins—771, "Homemade Fireless Cookers and Their Use"; 806, "Bread and Bread Making in the Home"; 861, "Removal of Stains from Clothing and other Textiles"; 871, "Fresh Fruits and Vegetables as Conservers of Other Staple Foods"; and 881, "Preservation of Vegetables by Fermentation and Salting." Farmers' Bulletin 712, "School Lunches," has been revised. An extension circular on "Home Canning Club Caps and Aprons" has been published. Upward of 100 summaries and syndicate articles and other publicity material have also been prepared. The work continues to supply, as in the past, popular summaries and materials useful in the increasingly large correspondence with housekeepers, extension workers, and home-economics students and teachers.

The studies of the utilization of foods by the body continue to supply more exact data regarding the thoroughness of utilization by the body and the food value of cereal grains and their products, fats of animal and vegetable origin, and other foods under different conditions. The more recent publications have included Department Bulletins 612, "The Digestibility of the Dasheen," and 630, "Studies on the Digestibility of Some Nut Oils." In addition to some miscellaneous studies of fish and fish products, studies of the digestibility of mackerel, butterfish, salmon, and grayfish have been conducted, in cooperation with the Bureau of Fisheries, which has recently given considerable attention to the development of a market for the grayfish, and have resulted in the publishing of Department Bulletin 649, "Experiments on the Digestibility of Fish." During the past year digestion experiments have been made of certain compounded rations considered in studies of emergency rations adapted for Army use, conducted in cooperation with the food division, Surgeon General's Office, War Department. Studies of the digestibility of cereal flours are being made, in cooperation with the Food Administration.

*Assignment.*—C. F. Langworthy, A. D. Holmes.

*Proposed expenditures 1918-19.*—\$32,660.

(See also Supplement—Emergency Activities, p. 568.)

### **Respiration Calorimeter Investigations:**

*Object.*—To study agricultural products with reference to their use in the home for food, clothing, and equipment, and the household tasks which their use involves, and to cooperate with other bureaus in investigations of problems for which the equipment and experience of this laboratory are specially suited.

*Procedure.*—Special calorimetric methods are used in the systematic study of food, clothing, and household equipment in relation to work in the home and in the special studies undertaken in cooperation with other bureaus.

*Cooperation.*—Other bureaus of the department.

*Location.*—Washington, D. C.

*Date begun.*—1894.

*Results.*—The work continues to supply, as it has done in the past, more exact information regarding the subject matter of home economics than has hitherto been available for the use of extension workers, teachers, students, and housekeepers, while the cooperative investigations furnish data necessary for the proper solution of various agricultural problems. During the past year control tests with the improved respiration calorimeter have been completed, and experiments have been carried on to measure the energy expenditure in different lines of household work, such as food preparation, cleaning, and sewing, which supply new and much-needed data for the discussion of problems of household labor. A summary, unpublished, of data on this subject has been prepared, and an article reporting the results of experimental work will be completed. The study of problems relating to the wintering of bees has been continued, in cooperation with the Bureau of Entomology.

*Assignment.*—C. F. Langworthy, A. D. Holmes, H. G. Barott.

*Proposed expenditures, 1918-19.*—\$11,000.

**Total, Home-Economics Investigations, \$43,660, including \$13,540 statutory.**



## BUREAU OF PUBLIC ROADS.

### GENERAL ADMINISTRATION.

#### General Administration:

*Object.*—To administer the investigational, extension, and regulatory activities of the bureau; to carry on its business affairs, correspondence, accounting, etc.

*Location.*—Washington, D. C.

*Date begun.*—1893.

*Assignment.*—P. St. J. Wilson, J. E. Pennybacker.

*Proposed expenditures, 1918-19.*—\$30,515, including \$14,515 statutory (research, \$10,000; extension, \$5,515; regulation, \$15,000).

### ROAD MANAGEMENT.

#### Supervision:

*Object.*—To direct and supervise the various research and extension activities under this group and conduct routine office business, including correspondence, maintenance of records, purchase of supplies and equipment, and other clerical work.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Assignment.*—J. E. Pennybacker.

*Proposed expenditures, 1918-19.*—\$4,400 (research, \$3,000; extension, \$1,400).

[Research.]

#### Collection of Current Data Relating to Highways:

*Object.*—To assemble and systematize all available information and statistics relative to highways, including the maintenance of a current record and the compilation of road legislation. This project covers all statistical studies, except the census of road mileage, revenues, and expenditures made at five-year intervals, and provides necessary information of a general or statistical character for the use of persons engaged in or aiding road improvement.

*Procedure.*—Members of the State highway departments and, in a few instances, collaborators employed by this bureau report under prescribed headings from time to time. The information thus obtained is assembled in a State index, which is kept up to date. In addition, special inquiries are sent from time to time to State highway departments and other sources of information, the compilation of road laws is conducted, and all technical and trade publications bearing upon road improvement are freely consulted. Publications are issued at intervals containing data thus obtained.

*Cooperation.*—State highway departments and various other sources of information.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Results.*—The current material has been used freely for correspondence and reference purposes, and, in addition thereto, circulars have been issued giving information relative to State highway mileage and expenditures for the current calendar year and regarding automobile registrations and amounts of revenue derived therefrom and applied to the roads.

*Assignment.*—A. P. Anderson.

*Proposed expenditures, 1918-19.*—\$8,806.

(Observation of Experimental Convict Camp in Connection with Road Management: Project completed; results published in Department Bulletin 583.)



(**Economic Studies of Selected Post Roads:** Project completed; information prepared in multigraph form and used in correspondence on the subject; no formal bulletin yet prepared.)

### **Economic Studies of County and Township Highway Systems:**

*Object.*—To ascertain by personal studies the organization, procedure, cost of operation, and results obtained in counties and townships in various parts of the United States; to find out the types of road, character of materials, and methods of maintenance which are yielding the best results at the least cost; and to determine the elements of weakness in various local systems of management.

*Procedure.*—Counties are selected, located in various parts of the United States and presenting all conditions that exist throughout the country as to character of material, methods of construction, topography, character and extent of traffic, systems of organization, methods of financing, construction, maintenance, etc. Each of these selected counties is made the object of a thorough study by an engineer assigned for that purpose. It is believed that these studies will form an accurate index for the country as a whole. The individual reports by counties will be filed in the office and utilized in the preparation of bulletins.

*Cooperation.*—Local officials.

*Location.*—Various counties throughout the United States.

*Date begun.*—1914.

*Results.*—Field studies have been completed in 50 counties. A cost-keeping bulletin has been prepared, and one on maintenance and another on highway organization and procedure are nearly completed.

*Assignment.*—R. F. Eastham, A. C. Dunn, I. W. Hall.

*Proposed expenditures, 1918-19.*—\$7,186.

### **Economic Studies of State Highway Systems:**

*Object.*—To ascertain the character of organization, working plan, cost of operation, systems of report and record, character and cost of work done, classification of highways, and purposes served; and so to correlate and present the information as to make it useful to the National Government for military and postal purposes and in connection with the administration of the Federal-aid road act, as well as useful to the States in the establishment and management of systems of State highways.

*Procedure.*—The more important roads and bridges of each State are inspected and information relative thereto compiled, with a view to the publication of the data obtained in the form of appropriate bulletins and maps.

*Cooperation.*—State highway departments.

*Location.*—Various States, with the idea of ultimately covering the United States.

*Date begun.*—1914.

*Results.*—An economic-highway survey was made in Maryland, New Jersey, and Connecticut and a plan worked out for the general extension of this survey in cooperation with State highway departments. Topographic sheets were made as a basis, and from these highway maps were prepared expeditiously, in the greatest detail, at an average cost for field and office work, including materials, of about 75 cents per mile. Much of the information was adapted to military use and was furnished to the War Department as rapidly as the work could be completed. Much economic data bearing upon classification of roads as to their relative importance have been assembled.

*Assignment.*—C. H. Kendall, Clifford Shoemaker, A. L. Luedke, L. H. Schlegel, H. E. MacEwen, J. L. Harrison, G. G. Clark, W. A. Marcey.

*Proposed expenditures, 1918-19.*—\$20,006.

### **Traffic Studies:**

*Object.*—To assemble all practicable data on the regulation of traffic, the adaptation of various types of road surface to traffic conditions, and the relation of maintenance methods and cost to traffic requirements.

*Procedure.*—Engineers are assigned to study the methods pursued in various States and counties with reference to the handling of traffic problems, and information is obtained by correspondence and through a study of laws and reports, this being correlated with the field investigations made by engineers.



*Location.*—Various points to be determined from time to time.

*Date begun.*—1912.

*Results.*—Traffic studies on post roads have been completed, and the information obtained has been compiled and is being put in shape for use in a report to Congress. Traffic studies are being continued on the experimental roads already constructed by this bureau.

*Assignment.*—W. E. Rosengarten.

*Proposed expenditures, 1918-19.*—\$3,466.

[Extension.]

### Utilization of Convict Labor in Road Construction:

*Object.*—To make available to road officials and other interested persons the facts developed as a result of investigations regarding the management, operation, discipline, and results obtained in convict road camps, including tests, under cooperative arrangements with State and local authorities, of systems of record, cost keeping, and management devised by the Bureau of Public Roads.

*Procedure.*—Personal visits are made by representatives of this bureau and special reports prepared by collaborators appointed at selected camps.

*Cooperation.*—State highway departments, State prison commissions, and boards of county commissioners, and supervisors.

*Location.*—Various points yet to be definitely selected; advice given at points as covered by requests from time to time by State and local officials.

*Date begun.*—1914.

*Results.*—As a result of previous investigational work, supported by the most rigid practical demonstrations, information of a most exhaustive character as to the best methods of housing, managing, feeding, and working convicts on public roads has been obtained, and these results have been published in official bulletins. It is believed that wherever convicts may be utilized on road work the information compiled by this bureau will be of very practical value, and it is proposed to tender information and advice freely to all officials interested in this work.

*Probable date of completion.*—1919.

*Assignment.*—R. F. Eastham.

*Proposed expenditures, 1918-19.*—\$1,606.

### Advice, Lectures, and Demonstrations:

*Object.*—To provide expert advice on legislation, organization, and road management, and to aid in intelligent propaganda through conferences, lectures, and demonstrations.

*Procedure.*—Advice, lectures, and demonstrations are given upon the request of public officials and organizations. Road and bridge models are made and lantern slides prepared and colored for use in this work. Models are sent out on condition that transportation expenses will be paid by the local organizations. Demonstrators are assigned at the expense of the bureau.

*Cooperation.*—Highway officials and public and private organizations; also State agricultural colleges, through the States Relations Service.

*Location.*—United States.

*Date begun.*—1893.

*Results.*—As this is a current project, consisting of the dissemination of information of practical educational value and the stimulation of interest in practical road improvement, the results are fairly similar each year.

*Assignment.*—M. O. Eldridge, J. L. Harrison.

*Proposed expenditures, 1918-19.*—\$7,725.

**Total Road Management, \$53,195, including \$13,155 statutory (research, \$42,464; extension, \$10,731).**

## ROAD BUILDING AND MAINTENANCE.

### Supervision:

*Object.*—To direct and supervise the various research and extension activities under this group and carry on routine office business, including cor-



respondence, maintenance of records, purchase of supplies and equipment, and other clerical work.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Assignment.*—P. St. J. Wilson, Vernon M. Peirce.

*Proposed expenditures, 1918-19.*—\$9,600 (research, \$600; extension, \$9,000).

[Research.]

**Investigation of Costs of Road Maintenance:**

*Object.*—To investigate the costs of maintenance and to secure accurate cost data for various types of roads.

*Procedure.*—In counties where roads have been systematically improved under the direction of competent engineers, certain sections of improved roads are selected for the purpose of determining the relative value of various types of construction. The length of roads selected is from 15 to 40 miles, and the maintenance is conducted by the various counties. A nominal cost for furnishing these maintenance data is paid by the bureau. Traffic observations are taken on these roads for two or more periods of one week each for the purpose of amplifying and checking the observations made in connection with the experimental roads.

*Cooperation.*—State highway departments or road authorities in the several counties.

*Location.*—Montgomery County, Ala., Cumberland County, Me., Cayuga County, N. Y., Atlantic County, N. J., Milwaukee County, Wis., and Muskingum and Licking Counties, Ohio.

*Date begun.*—1907.

*Results.*—(1) During 1918: Special attention has been paid to the collection of accurate information which will be used in establishing a definite relation between the amount of traffic and the cost of maintaining the various types of road surfaces.

(2) Prior to 1918: Accurate data were secured covering the cost of maintenance of dirt, gravel, and bituminous macadam roads.

*Assignment.*—Vernon M. Peirce.

*Proposed expenditures, 1918-19.*—\$3,050.

**Investigations of Various Types of Road Construction and Costs:**

*Object.*—To study certain types of road construction which have been developed locally with available materials and under existing conditions, in order to be in a position to advise in regard to the best adaptable types of construction, such as bituminous-sand, rock asphalt, bituminous-surfaced gravel, patented types, etc.

*Procedure.*—Engineers will be assigned to visit the localities where these roads are being or have been built, in order to obtain a complete knowledge of the methods of construction, costs, and results.

*Cooperation.*—State highway departments or county road authorities.

*Location.*—Throughout the United States.

*Date begun.*—1917.

*Results.*—No previous work has been done on this project on account of the necessity of assigning engineers to other projects.

*Assignment.*—Vernon M. Peirce.

*Proposed expenditures, 1918-19.*—\$5,700.

[Extension.]

**Object-Lesson Roads:**

*Object.*—To assist local road authorities by demonstrating proper methods of construction and the most efficient use of materials, to instruct them in the art of road building, and to correlate conclusions drawn from laboratory tests with those resulting from field-service tests.

*Procedure.*—Applications are received from local road authorities for advice and assistance in the construction of roads when funds are available and everything is ready for the work to proceed. These applications are acted upon, as far as possible, in the order of their receipt by this bureau. A highway engineer is detailed to superintendent the construction of a short section of road, as an object lesson to the local authorities, and remains upon the job until he has thoroughly instructed



the foreman, who is able to continue the work after the engineer has been given another assignment.

*Cooperation.*—State, county, and township authorities who have legal control of the roads to be improved, and the State agricultural colleges through the States Relations Service.

*Location.*—Object-lesson roads have been built in a great many different localities throughout the United States, and any political unit, excepting incorporated towns and cities, which makes proper application may receive this kind of assistance.

*Date begun.*—1904.

*Results.*—Local officials in charge of road work have been instructed as to the best methods of road construction, and improved methods of construction have been adopted by many of the various localities in which these roads have been built. Information has been secured and disseminated as to the cost and best methods of road construction.

*Assignment.*—Vernon M. Peirce.

*Proposed expenditures, 1918-19.*—\$12,000.

### Country Road Systems:

*Object.*—To study the roads of a county or other political subdivision and prepare general plans and specifications for their administration, improvement, and maintenance.

*Procedure.*—Experienced highway engineers are sent upon requests from county officials having jurisdiction of roads to advise with them in connection with the improvement of the county system of road supervision, improvement, and maintenance. These engineers go over the situation thoroughly, taking into account all the factors entering into the local problem, and then, in the light of their wide experience, formulate a plan of action for the improvement of roads throughout the county, considering the county as a unit.

*Cooperation.*—County officials in charge of roads in the various counties seeking this character of assistance and the State agricultural colleges through the States Relations Service. The Bureau of Public Roads furnishes a consulting engineer to cooperate with local officials.

*Location.*—Any county or political subdivision of similar size and importance which makes proper application.

*Date begun.*—1907.

*Results.*—Many counties have adopted the department's recommendations, reorganized and systematized their highway improvement work, and are now working along definite lines as to the ultimate system of roads to be built and their methods of construction and administration.

*Assignment.*—Vernon M. Peirce.

*Proposed expenditures, 1918-19.*—\$19,100.

### Inspection, Advice, and Lectures:

*Object.*—To make inspections, study specific local road problems, prepare definite recommendations for their solution, and bring this information to the assistance of road officials and others.

*Procedure.*—Upon request of road officials or interested civic organizations for assistance in the nature of advice, highway engineers are detailed to make inspections of local conditions and then give the required advice. The amount of assistance required in States and counties under this project will be greatly increased by operations under the Federal-aid road act of July 11, 1916. Advice and information will be necessary regarding the methods of making surveys and preparing plans, specifications, and estimates required by the act in connection with construction work. Considerably more inspection and advice will be necessary in connection with the methods and materials to be used by the local authorities in maintaining Federal-aid roads as required by the act. This project must be greatly increased in importance if response is to be made to those calls for assistance. Occasionally engineers are assigned to deliver lectures on specific and general highway-improvement problems before meetings of road officials, highway associations, and mass meetings of citizens.

*Cooperation.*—Township, county, and State authorities in legal control of the roads. The Bureau of Public Roads furnishes a consulting engineer to cooperate with the local officials.



*Location.*—Any place in the United States, provided proper application is made.

*Date begun.*—1894.

*Results.*—Requests are constantly being received for work under this project, which are cared for as far as possible in the order of their receipt. Many communities have secured the improvement of their roads in accordance with the advice given, and some have employed experienced highway engineers to continue such work. Engineers were assigned during the past year to advise and assist the constructing quarter-masters in the construction of roads leading to and within the 16 National Army cantonments. The lectures have resulted in informing a considerable number of residents of each community how the roads should be improved, the approximate cost of same, and the results and benefits to be expected.

*Assignment.*—Vernon M. Peirce and district engineers.

*Proposed expenditures, 1918-19.*—\$75,000.

### **Superintendence of County Roads:**

*Object.*—To demonstrate to county officials the advantages accruing from the supervision of all county roads by one skilled in highway construction and maintenance and the advantages of centralized control over all roads in a county.

*Procedure.*—When application for assistance has been made and contract entered into with this department, an engineer is assigned to take charge of the maintenance and construction of the county roads. This engineer supervises the building of roads and bridges, organizes a system for maintaining the roads, and introduces proper systems of reports and methods of accounting.

*Cooperation.*—County officials in legal control of the roads who have made application for assistance of this kind.

*Location.*—Any county which makes proper application.

*Date begun.*—1911.

*Results.*—County officials are convinced of the advantages of centralized control in the hands of qualified men, adopt the systems recommended, and elect or appoint county highway engineers.

*Assignment.*—Vernon M. Peirce.

*Proposed expenditures, 1918-19.*—\$5,000.

### **Bridge Construction in Connection with Road Building and Maintenance:**

*Object.*—To furnish local officials with plans and specifications for bridges and to investigate conditions and advise the authorities interested as to the best methods of bridge construction to meet their peculiar needs and conditions.

*Procedure.*—Standard plans and specifications of various types of structures are prepared and furnished to local officials and engineers upon request. Engineers visit communities and advise the authorities interested relative to special bridge problems and prepare plans to suit local conditions. They also superintend the construction of bridges to illustrate to local officials proper methods of construction. Operations under the Federal-aid road act will require much additional advice and investigation where counties and States propose bridge construction, and this work will also require extensive review of State standards, with the view of approving them as a whole for use on Federal-aid roads.

*Cooperation.*—State, county, and township authorities in legal control of the roads. The Bureau of Public Roads furnishes a consulting engineer to cooperate with the local authorities.

*Location.*—Any State or political subdivision, except incorporated cities or towns, which makes proper application.

*Date begun.*—1909.

*Results.*—Highway officials in various communities have been furnished plans and specifications and have been advised as to the best types and methods of bridge construction.

*Assignment.*—O. L. Grover, J. V. McNary, O. W. Childs.

*Proposed expenditures, 1918-19.*—\$38,000.

**(Improvement of Roads in National Forests:** Discontinued as a separate project; included under "National-Forest Road Construction Under the 10 Per Cent Fund—Construction and Maintenance.")



**Maintenance of Post Roads:**

*Object.*—To supervise the maintenance of certain post-road projects for the purpose of determining accurately the relation between the cost of effective maintenance and the available local funds and of determining maintenance costs on various types of roads; and to advise local road authorities.

*Procedure.*—The post roads built with funds provided under the act of August 24, 1912, are of concrete, bituminous-gravel, and macadam construction, and will be maintained, if possible, with local funds under the supervision of this bureau. This work will provide an unusual opportunity for the Government to secure accurate and detailed maintenance cost data on a large number of types of construction not otherwise available to it and will provide information desired and more and more frequently requested by engineers and local officials in all parts of the country.

*Cooperation.*—Local administrative units cooperating in post-road construction.

*Location.*—Maine, Ohio, and Maryland.

*Date begun.*—1914.

*Results.*—(1) During 1918: Systematic maintenance was continued on the Ohio, Maine, and Maryland post roads.

(2) Prior to 1918: The maintenance on the above mentioned roads was organized and cooperation begun with the local road officials.

*Assignment.*—Vernon M. Peirce.

*Proposed expenditures, 1918-19.*—\$1,450.

**(Washington-Atlanta Highway:** Project completed; no publication issued; results used in answering correspondence.)

**(Central Highway in North Carolina:** Project completed; no publication issued; results used in answering correspondence.)

**(Improvement of Post Roads:** Project completed. This project has been operated since 1913, pursuant to the act of Congress approved August 24, 1912. The improvement of seventeen roads has been completed under this act. These are located as follows:

Lauderdale County, Ala.; Boone and Story Counties, Iowa; Dubuque County, Iowa; Montgomery and Bath Counties, Ky.; Cumberland County, Me.; Montgomery County, Md.; Le Flore County, Miss.; McDowell County, N. C.; Davie, Forsyth, and Iredell Counties, N. C.; Muskingum and Licking Counties, Ohio; Jackson County, Oreg.; Aiken County, S. C.; Loudon County, Tenn.; Montgomery County, Tenn.; Travis, Hays, Comal, Guadalupe, and Bexar Counties, Tex.; Fairfax County, Va., and Spotsylvania, Caroline, and Hanover Counties, Va.)

**Total, Road Building and Maintenance,** \$168,900, including \$27,840 statutory (research, \$9,350; extension, \$159,550.)

[Research.]

**ROAD-MATERIAL INVESTIGATIONS.****Supervision:**

*Object.*—To administer the various activities under this group and conduct routine office work, including correspondence, maintenance of records, purchase of supplies and equipment, preparation of specifications, etc.

*Location.*—Washington, D. C.

*Date begun.*—1904.

*Assignment.*—Prévost Hubbard.

*Proposed expenditures, 1918-19.*—\$10,680.

**Routine Chemical Testing and Inspection:**

*Object.*—To conduct routine chemical tests and inspections of bituminous and nonbituminous dust preventives and road binders, with a view to determine their fitness for particular classes of work, conformity with specifications, etc. The inspection of culvert metal for use in roads built under the supervision of the bureau is also a part of this activity.



*Procedure.*—Samples are tested free of charge when submitted by State and county officials, good-roads organizations, etc., when by so doing information may be secured useful to the bureau in its efforts to co-ordinate laboratory results with service tests and in the preparation of typical specifications for materials of this character. Materials for use in the construction of roads under the supervision of the bureau are also tested for their conformity to specifications, and when the quantity of material involved warrants it an inspection is made at the plant of the manufacturer.

*Cooperation.*—Various State highway departments, in connection with Federal-aid projects.

*Location.*—Washington, D. C., and occasionally the plants where materials are manufactured.

*Date begun.*—1904.

*Results.*—(1) During the fiscal year 1918 the chemical laboratory examined 289 samples, including bituminous emulsions, fluxed native asphalts, oil asphalts, petroleums, residual petroleums, petroleum distillates, crude and refined coal tars and water-gas tars, bituminous aggregates, paving block, culvert metal, sand, cement, and concrete.

(2) Prior to 1918 the greatest number of samples examined during any one fiscal year was 474.

*Assignment.*—H. M. Milburn, R. H. Parker.

*Proposed expenditures, 1918-19.*—\$5,500.

### **Microscopic Examination and Classification of Road-Building Rocks:**

*Object.*—To examine microscopically and classify road-building rocks and to study the relation existing between their physical properties and mineral composition; and to investigate the mineral composition of blast-furnace and open-hearth slags in relation to their road-building qualities.

*Procedure.*—All samples of rock received for physical tests are submitted to the petrographer for identification and classification, and all crystalline rocks are subjected to microscopic examination for the purpose of determining their mineral composition.

*Location.*—Washington, D. C.

*Date begun.*—1901.

*Results.*—(1) During 1918: 630 samples of rock, gravel, sand, clay, slag, etc., were examined and classified.

(2) Prior to 1918: Office of Public Roads Bulletins 31 and 37 upon the examination and classification of rocks for road building were published. These discuss to some extent the physical properties of rocks with reference to their mineral composition and structure. They were followed by Department Bulletin 348, which gives a very complete treatment of the relation of mineral composition and rock structure to the physical properties of road material. A paper entitled "The Composition and Properties of Slag for Road Making" was also published in the proceedings of the seventh International Congress of Applied Chemistry.

*Assignment.*—E. C. E. Lord.

*Proposed expenditures, 1918-19.*—\$1,300.

### **Investigations of Dust Preventives and Road Binders:**

*Object.*—To investigate the effect of methods of production upon the character of bituminous materials, the relative fitness of the various types of bituminous materials for different classes of construction, and the changes which take place in these materials upon exposure to service conditions; and to conduct any other laboratory investigation which has for its purpose the production of improved materials or the securing of new data regarding materials at present in use.

*Procedure.*—Problems are suggested largely from observation of the behavior of materials in construction and maintenance work and are carried out when the volume of regular work permits.

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—(1) During 1918: A Department Bulletin entitled "Typical Specifications for Bituminous Road Materials" is in press. This bulletin contains a collection of specifications prepared by the bureau for oils, asphalts, and tars suitable for various types of roads. Directions for sampling and testing the materials are also included. The following subjects are under investigation: The effect of manufacturing processes



upon the physical and chemical properties of all types of bituminous road materials as determined in an experimental refining plant especially designed for the purpose; the thickness of bituminous films upon various types of mineral aggregates; the effect of colloids in bituminous materials; the effect of light on bitumens; and the toughness of fine bituminous aggregate as affected by the proportions and consistency of bitumen.

(2) Prior to 1918: An article upon the origin, manufacture, and use of bituminous and other materials in highway work was published under the title "Dust Preventives" as Office of Public Roads Bulletin 34. Other department publications include: Office of Public Roads Circulars—93, "Bitumens and Their Essential Constituents for Road Construction and Maintenance"; 96, "Naphthalene in Road Tars"; and 97, "Coke-Oven Tars of the United States"; also "The Toughness of Bituminous Aggregates," Journal of Agricultural Research, vol. 10, No. 2. Articles were also published in the proceedings of various societies or in technical journals on the following subjects: The physical and chemical characteristics of bituminous road materials, the effect of free carbon in tars, the effect of traffic on macadam roads surfaced with heavy oils, organic residues from soluble bitumen determinations, the effect of exposure on bitumens, and the effect of exposure on fluid bitumens.

*Assignment.*—Prévost Hubbard, H. M. Milburn.

*Proposed expenditures, 1918-19.*—\$6,030.

### **Experimental Bituminous Road Construction and Maintenance:**

*Object.*—To develop new types of bituminous-bound and bituminous-treated roads, and to correlate laboratory experiments with service tests.

*Procedure.*—Upon approved application for assistance in utilizing local materials with an artificial binder, a laboratory investigation of the project is made and a chemist assigned to cooperate in the construction. The regular maintenance of experiments thus far constructed is also included under this project.

*Cooperation.*—State and county authorities.

*Location.*—Various parts of the United States.

*Date begun.*—1905.

*Results.*—(1) During 1918: Supervision or inspection has been conducted in the construction and maintenance of a number of experimental sections in the vicinity of Washington and at other places throughout the United States. Inspections have been made of experimental soil asphalt, monolithic brick, and bituminous gravel roads in the middle-western and southern sections of the country and advice furnished relative to the construction of bituminous roads at a number of the Army cantonments.

(2) Prior to 1918: Experiments were conducted in various parts of the United States and detailed data in connection with these experiments published as annual circulars of the Office of Public Roads, as bulletins in the departmental series under the general title "Progress Reports of Experiments in Dust Prevention and Road Preservation," and in Department Bulletin 284. "The Construction and Maintenance of Roads and Bridges."

*Assignment.*—Prévost Hubbard, H. M. Milburn.

*Proposed expenditures, 1918-19.*—\$3,460.

### **Physical Tests of Road-Building Materials:**

*Object.*—To determine, by means of physical tests, the suitability of various materials for use in road construction.

*Procedure.*—Samples of rock, slag, gravel, sand, etc., are tested free of charge for any citizen of the United States and a report furnished him showing for what type of road construction the material is best suited.

*Cooperation.*—Various State highway departments, in connection with Federal-aid projects.

*Location.*—Washington, D. C.

*Date begun.*—1893.

*Results.*—(1) During the fiscal year 1918 the physical laboratory tested 1,009 samples, including rock, gravel, sand, sand-clay, clay, top soil, cement, concrete, slag, brick, etc. The results of physical tests of road-building rock in 1916 and 1917, including all compression tests to January 1, 1918, were published as Department Bulletin 670.



(2) The total number of samples of rock tested prior to 1918 was about 4,900. In 1912, Office of Public Roads Bulletin 44, "The Physical Testing of Road Building Rock," was published, giving the results of all rock tests made to July 1, 1911. In 1916, "The Results of Physical Tests of Road Building Rock" (to date of January 1, 1916), was published as Department Bulletin 370; and, in 1917, "The Results of Physical Tests of Road Building Rock in 1916," was published as Department Bulletin 537.

*Assignment.*—F. H. Jackson, jr., T. H. Bean.

*Proposed expenditures, 1918-19.*—\$4,185.

### Concrete Investigations:

*Object.*—To investigate the physical properties of concrete, including studies of the effect of flow, determination of the laws of expansion and contraction of concrete, factors involved in the distribution of stresses in reinforced slabs, study of strength of concrete bases, etc.

*Procedure.*—Tests are made on large-sized concrete specimens, such as cylinders, beams, and slabs. The loading is obtained by specially constructed apparatus at Arlington Farm, Va.

*Cooperation.*—American Society for Testing Materials and American Concrete Institute.

*Location.*—Washington, D. C., Arlington Farm, Va., Chevy Chase, Md., and Zanesville, Ohio.

*Date begun.*—1904.

*Results.*—(1) During 1918: The testing of large reinforced concrete slabs under concentrated loads was continued. The effect of both centrally and eccentrically placed loads has been studied, as well as the strengthening effect of parapet sides. The testing of large slabs under two-point loads has also been started. In cooperation with the Shipping Board numerous tests have been made upon reinforced concrete T-beams for the purpose of determining the safe unit shear required for economical design. Investigations are also being conducted with a view to determine the effect of various protective coatings for steel reinforcement used in concrete construction.

(2) Prior to 1918 the following official publications were issued: "Cement Mortar and Concrete," Farmers' Bulletin 235; "The Use of Concrete on the Farm," Farmers' Bulletin 461; and "Oil-Mixed Portland Cement Concrete," Office of Public Roads Bulletin 46, later revised and published as Department Bulletin 230. "The Expansion and Contraction of Concrete Roads" was also published as Department Bulletin 532. A paper was published in the 1913 Proceedings of the American Society for Testing Materials entitled "Some Tests of Reinforced Concrete Slabs under Concentrated Loads," and later two papers along similar lines were published, one under the title "Tests of Three Large-Sized Reinforced Concrete Slabs under Concentrated Loading," Journal of Agricultural Research, vol. 6, No. 6; the other, entitled "Tests of Large Reinforced Concrete Slabs," being published in the 1916 Proceedings of the American Concrete Institute. The data on these slab tests point directly to a more economical design of bridge floors than has heretofore been used. An apparatus for measuring the wear of concrete roads was devised and used in connection with experimental roads constructed under the supervision of the bureau. A description of this apparatus was published in the Journal of Agricultural Research, vol. 5, No. 20, under the title "Apparatus for Measuring the Wear of Concrete Roads." Other papers published in the proceedings of scientific societies or in technical journals were as follows: "The Expansion and Contraction of Concrete While Hardening," "The Dimensional Changes of Concrete While Hardening," "The Waterproofing Properties of Oil-Mixed Portland Cement Concrete," "The Flow of Concrete Under Sustained Loads," "The Cause of Cracks in Concrete Pavements," "The Influence of Total Width Upon the Effective Width of Reinforced Concrete Slabs Subjected to Central Concentrated Loading," "The Influence of Total Width upon the Effective Width of Reinforced Concrete Slabs Subjected to Eccentric Concentrated Loading," "The Flow of Concrete," and "Friction Tests of Concrete upon Various Sub-bases."

*Assignment.*—A. T. Goldbeck, W. E. Rosengarten, R. Harsch.

*Proposed expenditures, 1918-19.*—\$11,935.



**Nonbituminous Road-Material Investigations:**

*Object.*—To investigate the occurrence, method of production, and physical properties of nonbituminous road materials, correlate the results of physical tests with behavior in actual service, and develop tests to meet new conditions in road construction.

*Procedure.*—Samples are obtained from various sources representing materials which have given known results in actual service. The data obtained form the basis for arriving at limiting values, used to determine the fitness of material for any given type of construction. The production and manufacture of crushed stone, slag, and gravel are also studied in the field.

*Cooperation.*—Various State highway commissions, and stone quarries.

*Location.*—Washington, D. C., and points in the field.

*Date begun.*—1893.

*Results.*—(1) During 1918: A department bulletin entitled "Typical Specifications for Nonbituminous Road Materials" has been prepared. This bulletin contains a collection of specifications prepared by the bureau for broken stone, gravel, slag, sand-clay, sand, mineral filler, brick, and stone block suitable for various types of roads. Directions for sampling and testing the materials are also included. A department bulletin entitled "Small Scale Production of Crushed Stone for Public Roads" has been prepared. As a result of extensive quarry investigations in the New England and Middle Atlantic States, an article entitled "The Commercial Sizes of Broken Stone Aggregates" was published in "Public Roads," vol. 1, No. 2, and an article on "Fuel Economy in Connection with Highway Work" was published in vol. 1, No. 1, of the same magazine. Present investigations cover quarry practice and the size of commercial broken-stone products in the Ohio Valley, upper Mississippi Valley, and Southern States. The suitability of gravel and topsoil for road construction and the effect of various cushions and fillers for brick roads are also under investigation.

(2) Prior to 1918: "The Physical Properties of Rock for Road Building" was published as Office of Public Roads Bulletin 44 and the "Results of Physical Tests of Road Building Rock" as Department Bulletin 370. An article entitled "Influence of Grading on the Value of Fine Aggregates Used in Portland Cement Road Construction" was also published in the Journal of Agricultural Research, vol. 10, No. 5. The following results of researches were published in the proceedings of scientific societies or in technical journals: "The Physical Testing of Broken Stone Railroad Ballast"; "Relation Between the Tests for the Wearing Qualities of Road-Building Rocks"; "Gravel and Broken Stone; Qualities, Testing, and Selection for Road Building"; "Relation Between the Properties of Hardness and Toughness of Road-Building Rock"; and "Laboratory Tests of Brick Pavements."

*Assignment.*—F. H. Jackson, jr., G. E. Ladd.

*Proposed expenditures, 1918-19.*—\$9,960.

**Instrument Making and Repairing:**

*Object.*—To build and keep in repair testing machines and instruments required in conducting road-material investigations.

*Procedure.*—Machines and instruments used in the testing of road materials and for various purposes in connection with other activities of the bureau are constructed and kept in repair.

*Location.*—Washington, D. C.

*Date begun.*—1893.

*Results.*—Various testing and engineering instruments have been designed and repaired.

*Assignment.*—F. H. Schloer, E. C. Glasscocke.

*Proposed expenditures, 1918-19.*—\$7,040.

**Standardization of Methods of Testing Bituminous Road Materials:**

*Object.*—To revise current methods of testing bituminous road materials or develop and introduce new and better methods.

*Procedure.*—Certain work is undertaken as an assignment by the committee on standard tests for road materials of the American Society for Testing Materials. Proposed tests which appear in technical literature are investigated for the purpose of determining their value and new tests are devised.



*Cooperation.*—American Society for Testing Materials.

*Location.*—Washington, D. C.

*Date begun.*—1905.

*Results.*—(1) During 1918: As the result of cooperation with Committee D-4 on Road Materials of the American Society for Testing Materials, a revision of the standard method for distillation of bituminous materials suitable for road treatment was recommended for adoption, and standard definitions for petroleum, topped petroleum, rock asphalt, bituminous emulsion, viscosity and penetration, and standard needles for the penetration test as devised by the bureau were prepared. The following investigations were conducted: Relation between exposure and volatilization tests on tar products; physical tests of coarse bituminous aggregates; effect of controllable variables upon the melting-point test, and comparison of the volatilization test with the determination of the asphalt contents of road oils.

(2) Prior to 1918: An article entitled "Methods for the Examination of Bituminous Road Materials" was published as Office of Public Roads Bulletin 38. This article was later revised and published under the same title as Department Bulletin 314. Department Bulletin 555, containing recommended methods of sampling and testing various bituminous road materials as covered in highway specifications, was also published. The following papers were published in proceedings of scientific societies and in technical journals: "The Examination of Bituminous Road Binders," "The Determination of Soluble Bitumen," "A Useful Form of Pycnometer for Determining the Specific Gravity of Semi-Solid Bitumens," "Application of the Dimethyl Sulphate Test for Determining Small Amounts of Petroleum or Asphalt Products in Tars," "A New Penetration Needle for Use in Testing Bituminous Materials," "The Effect of Controllable Variables upon the Penetration Test for Asphalts and Asphalt Cements," and "A New Consistency Tester for Viscous Liquid-Bituminous Materials."

*Assignment.*—Prévost Hubbard, H. M. Milburn, D. Gordon.

*Proposed expenditures, 1918-19.*—\$985.

### **Standardization of Methods of Testing Nonbituminous Road Materials:**

*Object.*—To standardize physical methods of testing nonbituminous road materials, so that the results obtained by various laboratories may be compared.

*Procedure.*—Standard methods of testing are obtained by studying in detail various methods in common use, for the purpose of determining the one which will give the most accurate and trustworthy results.

*Cooperation.*—American Society for Testing Materials and Portland Cement Association.

*Location.*—Washington, D. C.

*Date begun.*—1893.

*Results.*—(1) During 1918: As the result of cooperation with Committee D-4 on Road Materials of the American Society for Testing Materials, the following standards were recommended for adoption: Toughness test for rock; determination of the apparent specific gravity of coarse aggregates; also standard definitions of clinker, mesh, slag, aggregate, screen, sieve, and bank gravel. A revision of the standard method of making a mechanical analysis of sand or other fine highway material was also recommended. The following investigations were conducted: Standardization of an abrasion test for gravel; standardization of a crushing strength test for rock; improvement of the standard abrasion test; and standard abrasion test for concrete.

(2) Prior to 1918: The bureau developed or perfected a number of tests for rock, such as the toughness test, the abrasion test, the hardness test, and the cementation test. Both the toughness and abrasion tests have been adopted as standard by the American Society for Testing Materials. A description of methods for the determination of the physical properties of road-building rock was published as Department Bulletin 347. Department Bulletin 555, containing recommended methods of sampling and testing various nonbituminous road materials as covered in highway specifications, was also published. Papers upon the "Effect of Controllable Variables upon the Toughness Test of Rock," and "The



Determination of the Specific Gravity of Nonhomogeneous Aggregates" were also presented before the American Society for Testing Materials.  
*Assignment.*—Prévost Hubbard, F. H. Jackson, jr.  
*Proposed expenditures, 1918-19.*—\$1,200.

**Total, Road-Material Investigations, \$62,275, including \$11,055 statutory.**

[Research.]

**FIELD EXPERIMENTS.**

**Supervision:**

*Object.*—To administer the various activities under this group and conduct routine office work.

*Location.*—Washington, D. C.

*Date begun.*—1911.

*Assignment.*—P. St. J. Wilson, Vernon M. Peirce, Prévost Hubbard.

*Proposed expenditures, 1918-19.*—\$5,835.

**Experimental Road Construction:**

*Object.*—To determine by experiments the relative merits and values of various preparations and materials for use in road construction and of the various methods and types of road construction.

*Procedure.*—A section of road is selected and certain experimental construction determined upon. Arrangements are then entered into with the local authorities looking to cooperation in the expense of construction under an agreement whereby this bureau retains the right to carry out the experiments decided upon, both in the matter of construction and of maintenance. The section of road selected is usually divided into a number of subsections, each of which is devoted to a separate experiment to compare the merits of the particular road materials and method used on that subsection with those used in other experiments.

*Cooperation.*—County and State officials in legal control of roads.

*Location.*—Montgomery County, Md.; Alexandria, Fairfax, and Prince William Counties, Va.

*Date begun.*—1911.

*Results.*—(1) During 1918: An experimental road was constructed in the grounds of the Department of Agriculture between Twelfth and Thirteenth Streets. The type of construction is bituminous macadam, using quartzite as a mineral aggregate, this being the first experimental road which the bureau has ever built with that material. The service of this road will be compared with other experimental roads that have been built in the department grounds.

Surveys have been made and plans and specifications prepared for the construction of an experimental road in Alexandria County, Va., locally known as the "Columbia Pike," from the Mount Vernon Avenue Road to beyond Barcroft, Va., a distance of about 3 miles. This work will be divided into several sections, each of a different type of construction, or on which different materials will be used, and most of these sections will be of a type different from any heretofore built. Arrangements have been made whereby Alexandria County, Va., will bear one-half of the expense of this work.

(2) Prior to 1918: Top soil, bituminous gravel, bituminous macadam, waterbound macadam (surface treated with various organic or inorganic materials), bituminous stone concrete, bituminous gravel concrete, Portland-cement concrete (plain and surface treated), and brick roads have been built and maintained. Complete descriptions of this work have been published in circulars from year to year. Many highway engineers have visited these roads and have received valuable information. Information as to the relative values of the various materials is being secured.

*Assignment.*—Vernon M. Peirce.

*Proposed expenditures, 1918-19.*—\$25,000.

**Traction Tests:**

*Object.*—To determine the effect of width of tire, diameter of wheel, type and size of axle bearing, kind of power, and method of application of power on tractive effort required to haul vehicles over various types of



road surfaces; to obtain comparative data on the resistance offered to traction by unimproved and improved road surfaces and by grades in the case of automobiles and horse-drawn vehicles; and to obtain information on the comparative pulling power and sustained effort and their relation to the rations of light and heavy draft animals.

*Procedure.*—The draft and horsepower required to operate loads of various capacities are determined by the use of special recording dynamometers designed in this bureau. The tests are made with loads of different magnitudes, using widths of tires ranging from  $1\frac{1}{2}$  inches to 6 inches. The tests have been conducted over all types and conditions of road surfaces.

*Location.*—Washington, D. C., and post and experimental roads throughout the United States.

*Date begun.*—1913.

*Results.*—(1) During 1918: Tests were discontinued during 1918, and will probably not be resumed until after the close of the war. Compilations were made of tests upon the draft required to operate vehicles, showing the effect of road improvement upon the post roads.

(2) Prior to 1918: Original and final tests were made on post roads in Iowa, Alabama, Maryland, Mississippi, Texas, South Carolina, Maine, Ohio, and Virginia and the results of same partially computed. Tests were made with constant loads on an earth road at the Arlington Farm, Va., the object being to determine the effect of width of tire on the road surface and also the draft required for the different widths of tires. Tests were made on the same road with varying loads to determine whether the draft required varies directly with the magnitude of the load. The work of calculating results of tests made in previous years was carried on throughout the fiscal year 1917. A circular was issued recommending widths of tires that should be used on wagons of different capacities for use over earth and gravel roads. Based on the requirements made in this circular, the National Association of Wagon Manufacturers has recently adopted standard tire widths for farm wagons. Much use has also been made of this circular by State authorities in formulating wide-tire laws.

*Assignment.*—E. B. McCormick.

*Proposed expenditures, 1918-19.*—No allotment; work temporarily suspended.

### **Experimental Road Maintenance:**

*Object.*—To conduct experimental maintenance for the purpose of securing accurate cost data for various types of roads.

*Procedure.*—Under specific appropriations this bureau constructs certain experimental roads. These have been built in the grounds of the Department of Agriculture at Washington, Montgomery County, Md., and Alexandria, Fairfax, and Prince William Counties, Va. To determine the relative value of various types of construction, consistent maintenance of the roads constructed is necessary for a considerable period. This maintenance is conducted by the bureau with funds from a specific appropriation for field experiments.

*Cooperation.*—Road authorities in Montgomery County, Md., and Alexandria, Fairfax, and Prince William Counties, Va., and the Bureau of Plant Industry.

*Location.*—Alexandria, Fairfax, and Prince William Counties, Va., Montgomery County, Md., and grounds of the Department of Agriculture at Washington, D. C.

*Date begun.*—1907.

*Results.*—(1) During 1918: Accurate data have been secured covering the cost of maintenance of bituminous macadam, bituminous concrete, cement concrete, and brick roads. Reports for the past year's work will appear in publications of the bureau. A large amount of accurate information is being collected, which will be used in establishing a definite relation between the amount of traffic and the cost of maintaining various types of road surfaces. If these studies, supplemented by the traffic observations being taken in different counties throughout the country, can be continued, the result will make a decided and valuable advance in the practical elements of highway engineering. The selections of surface types for given conditions may then be based on accurate knowledge instead of remaining a matter of loose judgment or guesswork, as at present.



(2) Prior to 1918: This project was begun in 1907 and was at first useful in developing new or unusual materials and methods to be used in the construction and maintenance of roads. As at present administered the prime purpose of the project is to develop comparable costs for construction and maintenance on which to base a more exact system of road design. The data secured since 1912 already furnish a valuable aid in correlating the amount of traffic, kind of construction, and cost of maintenance. Further refinement and amplification are extremely important, however, and are expected to result from the continuance of the project.

*Assignment.*—Vernon M. Peirce.

*Proposed expenditures, 1918-19.*—\$31,000.

### Road and Bridge Foundation Tests:

*Object.*—To determine the distribution of pressure through fills and foundations and to study the effect of loads on road surfaces and road foundations.

*Procedure.*—Concentrated loads are applied on fills of different depths and the intensity of distribution determined at various positions under the loads by means of specially designed weighing and loading devices. Studies are also made on nonbituminous pavements and on concrete foundations of various thicknesses when placed on different types of sub-base and subjected to concentrated loads. A study is also made of the effect of loads upon bituminous pavements constructed with various types and grades of bituminous material especially made for the purpose. Special apparatus is buried in position for measuring soil pressure against various structures.

*Cooperation.*—Office of Public Buildings and Grounds, Washington, D. C.; the Miami (Ohio) Conservancy District.

*Location.*—Washington, D. C., and Arlington Farm, Va.

*Date began.*—1915.

*Results.*—(1) During 1918: An article entitled "Tests to Determine Pressures Due to Hydraulic Fills" was published in the Engineering News Record. This article describes tests conducted in a large standpipe erected at the Arlington Farm and suggests a method for controlling the safety of hydraulic-fill dams during construction. Field tests of pressure in an earth fill in the District of Columbia and numerous laboratory tests of the distribution of pressure in sand fills under various methods of loading were conducted.

(2) Prior to 1918: Apparatus was devised for measuring the distribution of pressure through earth fills and a special soil-pressure laboratory building constructed at Arlington Farm. The following papers were published in the proceedings of the American Society for Testing Materials: "An Apparatus for Determining Soil Pressures" and "The Distribution of Pressures Through Earth Fills."

*Assignment.*—Prévost Hubbard, A. T. Goldbeck.

*Proposed expenditures, 1918-19.*—\$3,000.

**Total, Field Experiments, \$64,835, including \$4,835 statutory.**

### FARM IRRIGATION INVESTIGATIONS.

#### Supervision:

*Object.*—To supervise the field work of the farm irrigation division and direct the editorial, clerical, and other routine work.

*Location.*—Berkeley, Cal.

*Date begun.*—1899.

*Assignment.*—Samuel Fortier.

*Proposed expenditures 1918-19.*—\$6,465 (research, \$6,365; extension, \$100.)

[Research.]

#### Utilization of Water in Irrigation:

*Object.*—To determine the possibilities of utilizing water supplies now unused and of reclaiming waste lands for agricultural purposes; to determine what constitutes the best utilization of water in irrigation, as to the quantity used and method of applying, to serve as a basis for improving irrigation practice, for designing canals, pumping plants, and



farm ditches, for formulating ditch regulations and contracts, and for the granting and adjudicating of water rights, all with the view of lessening waste and bringing about the best use of the water resources.

*Procedure.*—The utilization of water is studied in the following ways: (1) Sections not now irrigated are studied to determine the possibilities of improving existing agriculture by the use of water or of reclaiming lands now unused because of lack of irrigation. (2) The quantity of water used and the area of land which it serves are determined as a basis for more exact studies of the quantities of water which should be used on various soils under different conditions. (3) Water is applied to fields by different methods and in different quantities, preceded and followed by soil-moisture determinations, to ascertain what soil-moisture conditions are most conducive to plant growth, what part of the water used is retained by the soil within the root zone of plants, and what methods give the most even distribution of moisture throughout the soil with the least loss by deep percolation and evaporation. (4) Tank experiments are conducted in which losses of water by evaporation and percolation from bare and cropped soils are determined by periodical weighings. (5) The movement of moisture in soils produced by the forces of capillarity and gravity is studied by special equipment in the laboratory and in the field in order to improve the present practice of distributing water. (6) The utilization of sewage for irrigation is studied for the purpose of working out methods by which crops may be irrigated with sewage without injury to soil and crops, at the same time providing satisfactory sewage disposal. (7) Irrigated valleys are studied to determine the possibilities of revising and combining canal systems so as to bring about a more economical use of water.

*Cooperation.*—States of California, Nevada, and Texas under direct appropriations; in California, Colorado, Kansas, New Mexico, and Utah, under agreements with the experiment stations.

*Location.*—Salt River Valley, Ariz.; Davis Farm, Sacramento Valley, and other sections of California; Cache La Poudre Valley, Colo.; Garden City, Kans.; Lamoille and other valleys in Nevada; Rio Grande Valley in New Mexico and Texas; and Cache Valley and other points throughout Utah.

*Date begun.*—1899.

*Results.*—(1) Prior to 1918: A large amount of information on the duty of water and on methods has been published in former years, and, largely as a result of this work, water is used more economically than previously. A series of practical bulletins dealing with irrigation practice have been prepared and published.

(2) During the fiscal year 1918 reports on irrigation in Florida, surface irrigation in humid sections, and evaporation from soil and water surfaces were published by the department. A report on capillary movement of moisture in soils has been prepared for publication. Reports of five years' cooperative experiments at the Davis Farm of the University of California, three years' cooperative work in irrigating alfalfa in the Sacramento Valley, two years' cooperative investigations of rice irrigation in California, irrigation possibilities in Coachella Valley, Cal., and cooperative studies of irrigation of meadows in eastern Oregon have been published by the cooperating parties. Reports of two years' cooperative study of the duty of water in the Lamoille Valley, Nev., and of two years' experiments on the capillary movement of moisture in soils have been prepared. The compilation of a general report on duty of water has been begun. The field work for a report on the use of water in the Cache La Poudre Valley in Colorado has been completed and the preparation of a report for publication begun. A report on irrigation possibilities in the Mojave River Valley, Cal., has been prepared. Plans for revising and combining canal systems in Utah have been prepared and carried out.

*Assignment.*—Samuel Fortier, W. L. Rockwell, W. W. McLaughlin, L. M. Winsor.

*Proposed expenditures, 1918-19.*—\$31,963.

### **Pumping for Irrigation:**

*Object.*—To increase the utilization of underground water for irrigation by aiding farmers in sinking and casing wells and in selecting, installing, and operating pumping equipment; and to make investigations



leading to the improvement of wells and pumping equipment and their adaptation to irrigation requirements.

*Procedure.*—Existing pumping plants are tested to determine the efficiency at which they are working, and improvements are suggested. Existing wells not used for irrigation are tested to determine the sufficiency of the water supply for irrigation. Farmers are assisted in increasing the capacity of their wells, pumping plants are designed for farmers, and they are assisted in installing and operating the plants. Laboratory and field tests of pumping plants are made with a view to develop improvements in design. Records are kept of the cost of operating pumping plants in use in order to obtain the data necessary for advising farmers as to the feasibility of pumping for irrigation in different sections.

*Cooperation.*—California State Department of Engineering, University of California; Texas, Kansas, Nebraska, and Utah experiment stations; State Engineer of Nevada, and Nevada State University.

*Location.*—Throughout the arid region.

*Date begun.*—1899.

*Results.*—(1) Prior to 1918: Several bulletins giving the results of pumping investigations have been published by the Office of Experiment Stations in the past. Data were published in O. E. S. Bulletins 181, 183, 191, and 201 and Farmers' Bulletins 277 and 394.

(2) During the past year the preparation of a general treatise on pumping for irrigation has been continued. A report of pump tests made at the New Mexico Agricultural College has been completed and submitted for publication. A report on pumping for irrigation in Kansas and Nebraska has been prepared. Throughout the country work was done in advising farmers and communities as to equipment for pumping and in designing pumping plants for them.

*Assignment.*—M. B. Williams, F. L. Bixby, C. G. Haskell, L. M. Winsor.

*Proposed expenditures, 1918-19.*—\$10,466.

### **Irrigation Appliances and Equipment:**

*Object.*—To develop the best general types of structures and equipment for diverting, transporting, dividing, distributing, and applying water used for irrigation. This affords a basis for advising farmers as to improving present practices in regard to the kind of equipment to install and as to changes and improvements in works already in use.

*Procedure.*—This investigation consists principally of observing structures in use and studying their adaptation to the purpose which they are intended to serve, the making of experiments to develop new equipment, and studies of the construction, maintenance, and operation of irrigation canals and equipment generally, with a view to advise farmers as to improvements.

*Cooperation.*—University of California.

*Location.*—Throughout the United States. The nature of the work is such that it can not be localized.

*Date begun.*—1899.

*Results.*—(1) Prior to 1918: Many of the results of work of this kind have been published in Farmers' Bulletins in the past. More recently bulletins on gate structures (Department Bulletin 115), concrete linings for canals (Department Bulletin 126), wood stave pipe (Department Bulletin 155), spray irrigation (Department Bulletin 495), and farm reservoirs (Farmers' Bulletin 828) have been published.

(2) During the past year experiments in the manufacture and use of concrete pipe for irrigation have been conducted, methods of decreasing the deposit of silt in canals and of removing silt from canals studied, studies of various structures used in irrigation canals carried on, and a report on spillways prepared for publication.

*Assignment.*—Samuel Fortier, C. E. Tait, A. T. Mitchelson.

*Proposed expenditures, 1918-19.*—\$6,863.

### **Flow of Water for Irrigation in Ditches, Pipes, and Other Conduits:**

*Object.*—To test the accuracy of formulas for the flow of water in conduits of various kinds and to work out new formulas in order that conduits may be properly designed to carry the water which they are intended to convey.



*Procedure.*—Very careful and accurate measurements of the discharge of existing conduits are made, and from the results existing formulas are checked and new formulas developed.

*Cooperation.*—United States Reclamation Service.

*Location.*—Throughout the United States. As the observations are made on conduits already installed, the work is conducted wherever the desired kinds of conduits may be found.

*Date begun.*—1900.

*Results.*—(1) Prior to 1918: Many data have been obtained, but nothing was published until 1914. The results of measurements of flow in concrete-lined channels were published in Department Bulletin 126; the results for open channels generally were published in Department Bulletin 194 and the results of measurements on wood pipe in Department Bulletin 376.

(2) During the past year work on concrete pipe, begun in previous years, was completed and a report prepared for publication.

*Probable date of completion.*—1919.

*Assignment.*—F. C. Scobey.

*Proposed expenditures, 1918-19.*—\$3,272.

### **Measurement of Water for Irrigation:**

*Object.*—To improve and standardize devices for measuring water for irrigation. The economical use of water and good agricultural practice require that the water used for irrigation be measured. Up to the present time no satisfactory means for measuring the small streams delivered to individual farmers have been devised, while the devices which are in use have not been accurately calibrated.

*Procedure.*—A hydraulic laboratory is maintained at Fort Collins, Colo., in cooperation with the Colorado Experiment Station, where the flow through various measuring devices is checked by volumetric measurements in carefully calibrated tanks; at Cornell University devices of large sizes are calibrated. Discharge formulas and discharge tables are developed from the results of these experiments. New devices will be tested and experiments to develop more satisfactory methods made. At the Davis farm of the University of California the discharges of the measuring devices used in that State and elsewhere are checked against standard weirs. Canal companies and individuals are supplied with designs and discharge tables and are assisted in installing and operating measuring devices.

*Cooperation.*—Work in Colorado is done under cooperative agreement with the Colorado Experiment Station and that in California under agreement with the University of California. Work is also done at the hydraulic laboratory of Cornell University; at Cornell University devices of larger size than can be tested at Fort Collins are calibrated.

*Location.*—Fort Collins, Colo., Davis, Cal., and Ithaca, N. Y.

*Date begun.*—1899.

*Results.*—(1) Prior to 1918: In past years much information on this subject was published in the bulletins of the Office of Experiment Stations. Several reports of the work at the Fort Collins laboratory have been published by the department in the Journal of Agricultural Research and by the Colorado Experiment Station and a Farmers' Bulletin (813) on farm weirs has been prepared and published. Application for the public patent of a promising device developed at Fort Collins has been made. A report of work at Davis was published by the University of California.

(2) During the past year work of this kind has been curtailed considerably because of more urgent emergency work.

*Assignment.*—R. L. Parshall.

*Proposed expenditures, 1918-19.*—\$1,931.

### **Customs, Regulations, and Laws Relating to Irrigation:**

*Object.*—To determine the effect of customs, regulations, and laws upon the use of water by farmers under irrigation, upon the economical use of water from the standpoint of the public, and upon the success of irrigation development, and to suggest desirable changes to legislatures. The fact that the supply of water for irrigation is limited and that it is practically impossible for a farmer individually to provide himself with a water supply for irrigation or to protect his water supply from being



used by others has led to a high degree of public control over the use of water for irrigation and to an elaborate organization for providing a water supply. Irrigation practice is, therefore, controlled to a very large extent by customs, regulations, and laws, which have fully as large an influence on the success of farmers under irrigation and on the best use of limited resources as have physical conditions.

*Procedure.*—The operation and effect of the customs, regulations, and laws controlling the use of water for irrigation are studied through correspondence and through field employees, and reports based on the results of these studies are prepared. On request, advice is given to legislative committees and others as to legislation and organization. Communities are advised as to reorganization in connection with the revision of canal systems. The division is called upon by the Federal Farm Loan Board for reports on irrigation systems where landowners apply for loans; also by the Capital Issues Committee of the Federal Reserve Board for reports on enterprises for which it is proposed to issue securities.

*Cooperation.*—State Engineering Department of California, University of California, Utah Experiment Station, and State Water Commission of Utah.

*Location.*—Headquarters at Berkeley, Cal.

*Date begun.*—1899.

*Results.*—(1) Prior to 1918: For several years after beginning irrigation investigations a large part of the work done was of the character outlined in this project, and a number of bulletins giving the results have been published, including Office of Experiment Stations Bulletins 60, 70, 100, 105, 130, 144, 157, 168, 192, and 229.

(2) During the past year a Farmers' Bulletin on water rights was prepared and submitted for publication. A study of the administration of water laws of several States was made in connection with work in drafting an irrigation code for the State of Utah. The legislatures of the arid States were in session during the winter of 1917, and considerable work was done in advising as to proposed legislation.

*Assignment.*—R. P. Teele, Frank Adams.

*Proposed expenditures, 1918-19.*—\$6,932.

### Drainage of Irrigated Lands:

*Object.*—To protect irrigated lands from deterioration due to rise of ground water and the accumulation of alkali; to reclaim lands injured from these sources; and to drain swamp and overflowed lands in the West.

*Procedure.*—The work consists very largely in assisting communities and individuals in preparing plans for draining water-logged and alkali lands, in organizing to secure drainage, and in installing drains. Observations of ground-water level and surveys are made, plans prepared, recommendations made to communities and landowners regarding systems of drainage, and the installing of drains supervised. Assistance in drafting drainage legislation is given to legislative committees.

*Cooperation.*—Colorado, New Mexico, Nevada, and Utah experiment stations.

*Location.*—Throughout the arid regions of the United States.

*Date begun.*—1903.

*Results.*—(1) Prior to 1918: Plans for the drainage of many districts and individual farms throughout the West have been prepared and drains installed on these plans, resulting in the protection or reclamation of large areas. A Farmers' Bulletin on the drainage of irrigated lands was prepared and published. Much assistance in drafting legislation has been given to the Western States.

(2) During the past year several districts in Colorado, Utah, Idaho, Wyoming, and Washington have been assisted, and as a result drainage of considerable acreage is under way. In Utah, assistance has been given to individual farmers, resulting in the drainage of several thousand acres.

*Assignment.*—R. A. Hart, M. R. Lewis.

*Proposed expenditures, 1913-19.*—\$16,048.

### Irrigation in Humid Region:

*Object.*—To investigate the practicability of irrigation in humid regions, where rainfall ordinarily is sufficient for most field crops, and to study the equipment for irrigation plants in those regions.



*Procedure.*—By personal inspection and interviews with landowners, investigation is made of the value and need of irrigation under various conditions of climate, soil, and crops. Experiments are conducted for determining the suitability of using sewage for irrigation in humid regions, as a means of sewage disposal as well as of increasing crop yields. Studies are made of the equipment used for pumping and distributing irrigation water and of improvements that may be made. In cooperation with State and local institutions and individual farm owners, experimental irrigation plants are installed with which to study the special problems.

*Cooperation.*—Institutions and individual landowners.

*Location.*—Eastern and central United States.

*Date begun.*—1908.

*Results.*—(1) Prior to 1918: Data published in Department Bulletins—462, "Irrigation in Florida," and 495, "Spray Irrigation."

(2) During 1918: Farmers' Bulletin 899, "Surface Irrigation for Eastern Farms," was published. An automatic nozzle for spray irrigation systems has been developed, also an automatic valve for distributing sewage upon irrigated plots. A method of reinforcing clay pipe with wire and concrete has been devised for use in irrigation distribution systems at a cost considerably less than for iron pipe. Experiments in sewage irrigation in the Middle Atlantic States have shown large increase in crop production.

*Assignment.*—S. H. McCrory.

*Proposed expenditures, 1918-19.*—\$5,349.

[Extension.]

**Expert Advice and Assistance:**

*Object.*—To assist in irrigation development and the improvement of irrigation practices by giving technical advice relating to methods and equipment for irrigation.

*Procedure.*—A large part of this work consists of replying to letters asking for information or advice. In other instances engineers visit farmers, investigate their conditions, and give the necessary advice as to equipment and instructions for its installation.

*Cooperation.*—State agricultural colleges through the States Relations Service and owners of plants.

*Location.*—Headquarters at Berkeley, Cal.; work covers the whole country.

*Date begun.*—1899.

*Results.*—Definite results are difficult to trace, but the giving of practical advice tends to improve irrigation practice and bring about a better use of water.

*Assignment.*—Samuel Fortier.

*Proposed expenditures, 1918-19.*—\$2,466.

**Total, Farm Irrigation Investigations,** \$91,755, including \$9,315 statutory (research, \$89,189; extension, \$2,566).

**FARM DRAINAGE INVESTIGATIONS.**

**Supervision:**

*Object.*—To supervise farm drainage investigations and direct the necessary clerical, editorial, and other routine work incident thereto.

*Location.*—Washington, D. C.

*Date begun.*—1903.

*Assignment.*—S. H. McCrory.

*Proposed expenditures, 1918-19.*—\$11,510 (research, \$6,810; extension, \$4,700).

[Research.]

**Construction, Operation, and Maintenance of Drainage Improvements:**

*Object.*—To study the cost and efficiency of machines and implements for digging ditches and building levees under various conditions of work; to study the sizes, types, and arrangement of pumping equipment suitable for drainage works; to investigate the strength and durability of tile, especially of cement tile in various soils; to make a study of the



cost of construction, operation, and maintenance of drainage improvements and an analysis of such costs; and to determine the rate of depreciation of drainage improvements.

*Procedure.*—Data are collected by correspondence and by personal inspection from manufacturers, owners, and operators of equipment, from officers of drainage districts, and from individuals. Field experiments are made, on short stretches of typical ditch sections, to determine methods and cost of keeping drainage ditches in good order after construction, under various conditions of climate, soil, vegetation, and topography.

*Cooperation.*—Bureau of Standards, Reclamation Service, and drainage districts.

*Location.*—United States.

*Date begun.*—1903.

*Results.*—(1) Prior to 1918: The following publications were issued: Department Bulletins—71, "Wet Lands of Southern Louisiana and Their Drainage"; 300, "Excavating Machinery Used in Land Drainage"; and 304, "Land Drainage by Means of Pumps"; and Farmers' Bulletin 698, "Trenching Machinery for Tile Drain Construction." Manuscript reports upon drainage pumping plants in Louisiana and upon storm tides along the central Gulf coast have been prepared.

(2) During 1918: Technologic Paper 95 of the Bureau of Standards, Department of Commerce, contains the results of the first three years' tests relating to the durability of concrete tile in alkaline soils. An investigation of drains in some Southeastern States indicates that home-made concrete tile there are rather liable to deterioration. Further data have been compiled and manuscript reports prepared relating to the effectiveness of completed drainage works, the design and operation of drainage pumping plants, methods and costs of construction and maintenance of drainage ditches, and ditching plows for excavating trenches for tile drains.

*Assignment.*—S. H. McCrory.

*Proposed expenditures, 1918-19.*—\$10,740.

### **Drainage of Peat, Turf, and Muck Soils:**

*Object.*—To study special problems involved in planning and constructing drainage systems for peat, turf, and muck soils.

*Procedure.*—Investigations are made to determine the amount of shrinkage or contraction of such soils after drainage improvements have been constructed. The relative advantages and disadvantages of open ditches and tile drains in such soils are studied. Investigations are made to determine the rapidity with which the excess water should be removed from such soils and the height at which the ground water must be maintained to provide sufficient moisture for profitable agriculture.

*Location.*—Principally Louisiana and Florida in 1919.

*Date begun.*—1908.

*Results.*—(1) Prior to 1918: Investigations were made of drainage systems designed for peat, turf, and muck soils in New York and the North Central States and of the effectiveness of those systems. Studies relating to the compacting and subsidence of these soils in Louisiana and Florida, due to drainage and cultivation, have been made and a mimeographed report upon the subsidence of muck soils in southern Louisiana distributed.

(2) During 1918: Profiles across a number of tracts of muck land in Louisiana and Florida, showing actual subsidence, were prepared and distributed.

*Assignment.*—S. H. McCrory.

*Proposed expenditures, 1918-19.*—\$2,390.

### **Drainage of Tillable Lands:**

*Object.*—To determine the proper depth, spacing, and arrangement of tile drains in various types of soils, the carrying capacities of tile drains, and the effect of drainage upon the soil temperature; to ascertain the amount of water that should be removed by tile drains per day from various kinds of soil under varying conditions of climate and topography; to investigate the effect of drainage on crop yields; and to determine the best methods of terracing to prevent washing and gullyng of hillside farm lands.



*Procedure.*—Accurate data are obtained to compare the effectiveness of drains variously arranged in different kinds of soil, to compare drained with undrained land, and to compare conditions of the same tracts before and after drainage. Measurements of flow from farm-drainage systems are observed in connection with the degree of drainage afforded by the drains. The necessary observations are made on tracts selected for farm-drainage extension work. The tests begun in 1915 to determine capacities of tile drains at various slopes will be continued. In sections of the country where terracing has been practiced studies of the various types are made.

*Cooperation.*—North Carolina Department of Agriculture, Alabama Experiment Station, and interested landowners.

*Location.*—Central and eastern United States.

*Date begun.*—1913.

*Results.*—(1) Prior to 1918: An article on "Economy of Farm Drainage" was published in the 1914 Yearbook of the department. Standard instructions for constructing tile drains have been distributed widely. Experiments have determined that in the black prairie belt of Alabama and Mississippi tile drains may be placed  $3\frac{1}{2}$  feet deep and 75 feet apart, instead of  $2\frac{1}{2}$  feet deep and only 40 feet apart. The utility of using dynamite for draining under some circumstances has been investigated. Brief reports have been made on the effects of tile drains upon the elevation and fluctuation of the ground-water table in Montgomery County, Ala., near Mount Jackson, Va., and near Easton, Md. Department Bulletin 512, "Prevention of Erosion of Farm Lands by Terracing," was issued. Experiments indicate that the capacities of tile drains are somewhat larger than generally had been supposed.

(2) During 1918: Manuscript for a Farmers' Bulletin on terracing has been prepared. Investigation has shown that, in general, drainage into shallow wells ("vertical drainage") has not been permanently satisfactory. Progress was made toward developing a new formula for computing capacities of tile drains.

*Assignment.*—S. H. McCrory.

*Proposed expenditures, 1918-19.*—\$11,940.

### **Organization, Financing, and Legal Regulation of Drainage Districts:**

*Object.*—To study the organization of drainage districts and the laws under which such districts are formed; to investigate the various methods of financing drainage districts; to determine the effect of customs and drainage laws and regulations upon the economical organization of drainage districts; and to study the various methods of assessing costs of drainage improvements.

*Procedure.*—The work is conducted through correspondence and personal interviews with bonding-house officials, attorneys of drainage districts and bonding houses, and drainage district officials. The reasons for the failure of drainage districts to meet their obligations are studied and an effort made to ascertain the number of such failures. Advice is given officials of proposed and organized drainage districts in proper methods of procedure in organization and in disposing of securities to raise funds for the payment of improvements. An endeavor is made to keep in close personal touch with districts from their inception, so that the greatest possible amount of authentic information may be collected.

Upon request from the Capital Issues Committee of the Federal Reserve Board, investigations are made of districts which have asked that committee to approve the issue of bonds for drainage work, and opinions are rendered to the committee regarding the need for the issues and the results that would be secured in increasing crop production.

*Location.*—Eastern and central United States.

*Date begun.*—1909.

*Results.*—(1) Prior to 1918: Assistance was given in framing general drainage laws for Alabama, Delaware, Georgia, Idaho, Maryland, Mississippi, New Mexico, North Carolina, South Carolina, Utah, Virginia, Washington, and West Virginia. Farmers' Bulletin 815, "Organization, Financing, and Administration of Drainage Districts," was issued.

(2) During 1918: Assistance has been given to many new and proposed drainage districts by advising with regard to financing and ad-



ministration. By request from the Advisory Committee to the Capital Issues Committee of the Federal Reserve Board, a considerable number of investigations have been made and opinions rendered to that committee relative to the propriety of approving proposed bond issues.

*Assignment.*—S. H. McCrory.

*Proposed expenditures 1918-19.*—\$2,090.

### **Run-off Investigations:**

*Object.*—To determine the rates of run-off which must be provided for by drainage channels in reclaiming wet lands and to determine the sizes of ditches necessary to remove the run-off. The latter investigation includes a determination of proper coefficients for hydraulic formulæ used in drainage engineering.

*Procedure.*—Gaugings are made of the rates of flood flow from drainage districts of known areas. As this rate is greatly affected by rainfall, topography, character of soil and vegetation, season, and size and shape of the drainage basin with reference to the arrangement of the tributary watercourses, data are collected relative to these conditions. At favorable locations actual measurements are made of the size and shape of the channel, slope of the water surface, and quantity of flow, and the condition of the channel with respect to roughness and uniformity is noted.

*Cooperation.*—Iowa Engineering Experiment Station and private engineers working in the vicinity where the investigations are being conducted.

*Location.*—Central and eastern United States.

*Date begun.*—1908.

*Results.*—(1) Prior to 1918: Measurements of run-off and corresponding precipitation records for south Louisiana, for Lee and Bolivar Counties, Miss., for Robeson County, N. C., and for west Tennessee have been distributed in mimeographed form. The reports for Mississippi, North Carolina, and Tennessee contain determinations of Kutter's roughness coefficient. Run-off records have been made in Arkansas, Illinois, Iowa, and Missouri.

(2) During 1918: A paper entitled "Run-off from Drained Prairie Lands of Southern Louisiana" was issued in the Journal of Agricultural Research, vol. 11, No. 6. A mimeographed report upon "Run-off from Florida East Coast Drainage Districts" was also prepared. Further data have been compiled from Florida, Iowa, South Carolina, and Tennessee.

*Assignment.*—S. H. McCrory.

*Proposed expenditures, 1918-19.*—\$8,360.

### **Drainage of Tidal Marshes:**

*Object.*—To investigate the cause of failure in many attempts made to reclaim tidal marsh land, and to determine the proper arrangement and size of sluice openings and the requisite storage capacity of ditches.

*Procedure.*—Examinations are made of areas where attempts have been made to embank and drain such land, and studies of the methods and cost of the work and the benefits obtained are conducted.

*Location.*—Eastern and southern coast States.

*Date begun.*—1903.

*Results.*—(1) Prior to 1918: Office of Experiment Stations Bulletin 240, "Tidal Marshes and Their Reclamation," was issued. Investigations were made of small tracts near San Francisco, on Puget Sound, and in New Jersey, plans for improving drainage being prepared for some of the areas.

(2) During 1918: Examinations and typewritten reports were made relative to three small tidal areas on the eastern coast.

*Assignment.*—S. H. McCrory.

*Proposed expenditures, 1918-19.*—\$300.

### **Drainage of Nonirrigated Western Lands:**

*Object.*—To study the needs of drainage in the humid regions of the Western and Pacific States, the practicability of organizing drainage districts, and the best design of drainage improvements for the soil and climatic conditions in those regions.

*Procedure.*—Investigations are made of areas that are wet continually or periodically to a degree injurious to agriculture, and assistance is given



to individual landowners and communities regarding the organization of drainage districts for securing reclamation of the lands. Some surveys are made and drainage plans prepared. Studies are made of the effects of drainage upon the condition of the soils and the benefits to crop yields.

*Cooperation.*—State institutions, drainage districts, and landowners.

*Location.*—Roughly, west of the 100th meridian.

*Date begun.*—1906.

*Results.*—(1) Prior to 1918: Many examinations have been made of areas of wet and overflowed lands, particularly in Washington, Oregon, and California. Plans in some detail have been prepared for overflowed lands on Colville River in Stevens County, Wash., and near Duvall, Wash.

(2) During 1918: Reconnaissance surveys were made of the proposed Coeur d'Alene and Pend Oreille drainage districts in north Idaho. A number of small surveys were made in eastern Washington and drainage plans submitted to the landowners. Plans were completed for 35,000 acres overflowed on Kootenai River between Bonners Ferry, Idaho, and the Canadian boundary.

*Assignment.*—S. Fortier.

*Proposed expenditures, 1918-19.*—\$5,970.

#### [Extension.]

### Drainage of Tillable Lands:

*Object.*—To teach landowners the proper methods of planning and constructing farm drains and terraces and to inform them concerning the benefits to be derived from such improvements.

*Procedure.*—From the requests received for assistance representative farms which will serve as good demonstrations are selected, consideration being given to the locations of the farms and the methods of farming practiced by the owners. A drainage or terrace system is designed and advice given during the construction of the system. In such instances the county agricultural agents often secure the attendance of many farmers, who are advised as to the proper methods of construction. In farming communities where farm drainage or terracing are not practiced meetings of farmers are addressed for the purpose of creating an interest in these forms of land improvement. Since the declaration of war special consideration has been given to requests for assistance in planning improvements for individual farms where the owners can proceed at once with construction and at once secure the benefits in greater crop yields.

*Cooperation.*—Through the States Relations Service, with the colleges of agriculture of Alabama and Georgia, the North Carolina Department of Agriculture, representative farmers, and interested landowners.

*Location.*—Eastern and central United States, particularly the Central and South Atlantic States and the lower Mississippi Valley.

*Date begun.*—1903.

*Results.*—(1) Prior to 1918: Results have been published in Maryland Experiment Station Bulletin 186, "Land Drainage in Maryland," in North Carolina Experiment Station Bulletins 234 and 236, "Farm Drainage in North Carolina" and "The Prevention and Control of Erosion in North Carolina with Special Reference to Terracing," and in Farmers' Bulletin 26 of the Virginia Department of Agriculture and Immigration, "Farm Drainage in Virginia." The large number of tile systems and terrace systems that have been installed by the landowners according to plans of this bureau are effectively demonstrating the value of farm drainage for increasing crop yields, making cultivation easier, and insuring against loss in wet seasons.

(2) During 1918: A manuscript on "Tile Drainage in South Carolina" has been submitted for publication as a bulletin by the State Commissioner of Agriculture. Advice has been given to a great number of farm owners regarding their special drainage problems. Plans have been prepared, during 12 months, for tile drains and terraces on 265 farm tracts. A number of demonstrations of construction methods have been held in cooperation with field agents of the States Relations Service. A series of lectures and demonstrations was made at the short course given in January by the Georgia State College of Agriculture at Athens, Ga.

*Assignment.*—S. H. McCrory.

*Proposed expenditures, 1918-19.*—\$23,880.



**Drainage of Overflowed Lands:**

*Object.*—To promote interest in the reclamation of lands subject to periodical overflow with the view of making them available for agriculture.

*Procedure.*—Surveys are made and plans prepared for the drainage of representative districts, selection of districts being made from requests received by the bureau. Meetings of interested landowners are addressed to explain the improvements needed and ways of organizing efficiently.

*Cooperation.*—States Relations Service, individuals, communities, and proposed drainage districts.

*Location.*—Eastern and central United States.

*Date begun.*—1903.

*Results.*—(1) Prior to 1918: Inspections have been made of a great number of districts which the landowners wished to protect from inundation and advice given with regard to the works that might be constructed with profit. Surveys and plans have been prepared for representative districts, of which the following have been published by the department: Office of Experiment Stations Bulletins 189, 198, 230, and 234, "Eastern Parts of Cass, Trail, Grand Forks, Walsh, and Pembina Counties, North Dakota," "Neosho Valley, Kansas," "St. Francis Valley Drainage Project in Northeastern Arkansas," and "Overflowed Lands in the Marais des Cygnes Valley, Kansas"; Office of Experiment Stations Circular 80, "Land in the Kankakee River Valley, Indiana"; Department Bulletins 181 and 198, "Overflowed Lands Along the Big Black River, Mississippi" and "Cypress Creek Drainage District, Desha and Chicot Counties, Arkansas." The greater number of reports are distributed only in typewritten or mimeographed form.

(2) During 1918: Inspections and preliminary report upon the feasibility of drainage have been made for a number of districts. Plans have been prepared for benefiting approximately 90,000 acres on the Saginaw River and tributaries in Michigan and about 40,000 acres on the Clear Boggy River in southeast Oklahoma.

*Assignment.*—S. H. McCrory.

*Proposed expenditures, 1918-19.*—\$8,360.

**Drainage of Swamp Lands:**

*Object.*—To promote interest in the reclamation of swamp lands with the view of making them available for agriculture.

*Procedure.*—Surveys are made and plans prepared for the drainage of representative districts. From the requests for assistance received by the bureau only those districts are selected which it is believed will serve as object lessons in swamp reclamation. Meetings of interested landowners are addressed to explain the character of improvements needed and the methods which should be pursued in effecting an adequate organization.

*Cooperation.*—States Relations Service, individuals, communities, and proposed drainage districts.

*Location.*—Eastern and central United States.

*Date begun.*—1903.

*Results.*—(1) Prior to 1918: By inspections and reports assistance has been given to a great number of owners of swamp areas in the reclamation of their lands where such reclamation could be profitably done. Surveys and plans have been made for some representative districts. Most of the reports are distributed only in typewritten or mimeographed form, but the following have been printed: Office of Experiment Stations Bulletins 244 and 246, "Belzoni Drainage District, Washington County, Mississippi" and "Back Swamp and Jacob Swamp Drainage District, Robeson County, North Carolina"; Office of Experiment Stations Circular 81, "Drainage of Agricultural Lands in Bolivar County, Mississippi"; Department Bulletins 114 and 193, "Black and Boggy Swamps Drainage District, Hampton and Jasper Counties, South Carolina" and "Drainage of Jefferson County, Texas."

(2) During 1918: A number of inspections have been made of comparatively small swamp areas and typewritten reports transmitted to landowners with recommendations regarding the construction work necessary for reclamation. A few surveys and plans have been made. Most of the projects have been in the South Atlantic States and lower Mississippi Valley.



*Assignment.*—S. H. McCrory.

*Proposed expenditures, 1918-19.*—\$4,490.

**Total, Farm Drainage Investigations,** \$90,030, including \$16,270 statutory research, \$48,600; extension, \$41,430).

[Research.]

## RURAL ENGINEERING INVESTIGATIONS.

### Supervision:

*Object.*—Supervision of rural engineering investigations, including necessary clerical, drafting, and other routine work and the purchase of equipment and supplies not properly chargeable to specific projects.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Assignment.*—E. B. McCormick.

*Proposed expenditures, 1918-19.*—\$3,000.

### Investigation of Farm Domestic Water Supply and Drainage Disposal:

*Object.*—To improve the sanitary conditions of the farms of the country by making available to farmers a knowledge of proper systems of plumbing, water supply, and drainage disposal, and to assist them in installing systems suited to the existing conditions.

*Procedure.*—Investigations are made of the conditions upon farms in various sections of the country. Systems, devices, materials, etc., now in common use are studied, and such of these as may be found adaptable are applied to rural conditions. Designs are prepared for water-supply and drainage-disposal systems suited to various conditions. The information acquired is disseminated by means of bulletins, lectures, correspondence, distribution of blue prints, and by personal advice and consultation when feasible.

*Cooperation.*—Owners and users of object-lesson and experimental installations designed by this division, and the extension division of the University of Tennessee.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) During 1918: A large amount of information relative to many phases of farm water supply and sewage disposal has been given through correspondence and personal interviews at the Washington office. Preliminary examinations and advice have been made at a number of farms in States near Washington, D. C. The features of a small gravity water system and household cooling tank were determined and outlined. The features of a septic tank installation to accommodate 25 people were determined, and the plant was built in New Jersey. The most important work of the year is the completion of a thoroughly practical bulletin on farm water supplies. The bulletin contains 51 illustrations from drawings prepared in the division and presents examples, advice, and data in great variety relative to safe, serviceable farm water systems. A similar bulletin on caring for the sewage and wastes on the farm is in course of preparation.

(2) Prior to 1918: The main purpose of the work of this office, whether through correspondence, interviews, or designs, has been to promote farm utilities that were (1) safe and (2) serviceable, and to discourage the use of makeshift devices or methods, which in the end are shown by experience to be generally unsafe, uneconomical, and disappointing. In furtherance of this policy a number of farm utilities have been designed and some have been installed by individuals or boards in various States. These installations have included sewage-disposal and water-supply systems in considerable variety. A typical gravity water-supply system was designed for a large Georgia farm. A lengthy lecture trip was made in the Middle and Pacific Northwest. An illustrated article entitled "Sewage Disposal on the Farm" was published in the 1916 Yearbook of the department.

*Assignment.*—E. B. McCormick, George M. Warren, A. M. Daniels.

*Proposed expenditures, 1918-19.*—\$6,610.

### Investigations of the Construction of Farm Buildings:

*Object.*—The preparation of drawings for all kinds of farm structures and equipment and for the general layout of the farmstead, with a view to



make the work of the farm less arduous and more efficient and the home life more attractive.

*Procedure.*—Conditions on farms in various sections of the country are investigated. Designs are prepared for farm residences of varying costs, accommodations, and styles to fit the conditions in the several geographical divisions of the country. Barns, other outbuildings, and equipment suited to the different types of farming in each section are designed. The drawings are published as prepared, and when a number of designs have been acquired there will be issued descriptive catalogues. Blue prints are supplied to those contemplating building; bulletins, lectures, papers, etc., are prepared on subjects connected with the work; and a wide correspondence is conducted with private parties seeking assistance on questions pertaining to farm structures.

*Cooperation.*—Various bureaus of the department and the extension division of the University of Tennessee.

*Location.*—Washington, D. C.

*Date begun.*—1915.

*Results.*—(1) During 1918: A very heavy correspondence relating to this work and covering a wide range of subjects has been handled. Many of the requests for assistance involve the preparation of sketches which are of special application and can not be used for general distribution. This is particularly true of those relating to farmstead planning, in which phase of the work a great many farmers have been given assistance.

The following designs have been prepared for general distribution: Sketch for a manure pit, four sweet-potato drying houses, four potato storage cellars, hollow-tile dairy barn, hollow-tile feed barn, wooden-hoop silo, calf barn, two combined corn cribs and granaries, farm shop building, and two bull barns.

The manuscript of a bulletin on farmstead planning, which was prepared during the preceding year, was rewritten.

Twenty distinct pieces of work, ranging from the tracing of drawings prepared in other offices to the designing and preparation of complete drawings and specifications for buildings to be used for experimental work, were executed for departmental bureaus. These included drawings and specifications for the reinforced concrete additions to the color laboratory of the Bureau of Chemistry at the Arlington Farm, Va., costing approximately \$15,000, and the laboratory building for the Bureau of Public Roads, to be erected at Arlington at a cost of \$75,000. Sketch designs were also prepared for all the other buildings comprising the main group of the proposed development of the Arlington Farm. This was done in cooperation with the Bureau of Plant Industry and the Fine Arts Commission.

Some of the work done for other branches of the department will be used for general distribution. The designs available to the public, prepared during the past year, have been limited, however, owing to the amount of work which the division has been called upon to do for other bureaus.

(2) Prior to 1918: Assistance was given to hundreds of farmers and others interested in the erection of farm structures and in matters related thereto by means of designs prepared since the inception of the work and by letter. A large model of a typical farmstead was prepared and exhibited. A short course of lectures on farmstead planning was given at Ames, Iowa. A large amount of architectural work was done for other bureaus of the department.

*Assignment.*—E. B. McCormick, M. C. Betts, M. A. R. Kelley, L. V. Lacy.

*Proposed expenditures, 1918-19.*—\$15,810.

### **Investigations of Rural Engineering Problems Involving Mechanical Principles:**

*Object.*—To investigate mechanical principles involved in various kinds of farm equipment with a view to standardization and the securing of data, which will be of assistance to farmers in selecting equipment, and to design new equipment and apparatus.

*Procedure.*—Farm equipment in common use is investigated, methods of testing developed, standards established which will enable farmers to determine for themselves the type of equipment best suited to their needs, and new equipment designed. The information obtained is issued in the form of bulletins, papers, blue prints, and general correspondence.



*Cooperation.*—American Society of Agricultural Engineers, National Gas Engine Association, Association of Tractor and Thrasher Manufacturers, and the extension division of the University of Tennessee.

*Results.*—(1) During 1918: Cost data of farm machinery and the raw products used in the manufacture thereof have been collected and compiled as a comparison of present prices with those of 1914.

In cooperation with the Office of Farm Management a questionnaire was sent to all known owners of internal-combustion tractors. The information obtained is being tabulated.

Structural and engineering data relating to 153 individual tractors was obtained and tabulated. The information was secured from manufacturers and has proved of great value in the work of this division in connection with tractors.

There was designed, assembled, and tested with success a portable engine-driven compressed-air sprayer for the Bureau of Plant Industry.

A survey and report was made relating to the availability of a small stream in Virginia as a source of power for a farm hydroelectric plant.

Heating plans were prepared for several buildings on experiment stations for other bureaus.

A heating plant was designed for a farmer in Ohio who is to cooperate with the division by furnishing data as to cost of installation, results, maintenance, etc.

In cooperation with the Bureau of Plant Industry, a portable engine-driven insecticide dust sprayer was designed for use in experimental work in combating the cotton-boll weevil. The machine was tested and proved mechanically successful.

Two bulletins of a series of the Office of Public Roads and Rural Engineering on the "Care and Repair of Farm Implements" were published, No. 3 dealing with plows and harrows and No. 4 with mowers, reapers, and binders.

Nine numbers of an information series (multigraphed circulars) on various rural engineering subjects were prepared for use in general correspondence.

The correspondence of the division has been heavy and includes a wide variety of subjects. A large proportion of the requests for information and assistance necessitated considerable technical research work, calculations, and designing. The information secured and used in this connection is filed and used when applicable, thus becoming routine matter, but individual problems continually arise so that a great deal of time is devoted to the handling of general correspondence.

(2) Prior to 1918: In addition to the dissemination of information through correspondence and other channels and the compilation of reference material for use in this connection, there were designed three systems for preventing or extinguishing grain-separator fires and also an apparatus for testing the draw-bar horsepower of tractors. An investigation was made of the use of denatured alcohol for heating, lighting, and power purposes. An extended study of the agricultural engineering work being done in the Middle West was made with a view to coordinate the work of the division with the need that exists. A mechanical silage tamper was designed.

*Assignment.*—E. B. McCormick, A. M. Daniels, E. Johnson.

*Proposed expenditures, 1918-19.*—\$6,615.

**Total, Rural Engineering Investigations, \$32,035, including \$7,035 statutory.**

[Regulation.]

## ROAD CONSTRUCTION UNDER THE FEDERAL-AID ROAD ACT.

### SUPERVISION OF RURAL POST-ROAD CONSTRUCTION.

#### Supervision of Rural Post-Road Construction:

*Object.*—To administer the Federal-aid road act (except section 8, relating to national-forest roads) in Washington and among the States; to supervise the expenditure of \$14,550,000 apportioned among the States for the fiscal year 1919 and the balance remaining from apportionments for the fiscal years 1917 and 1918; to inspect the location and layout of pro-



posed cooperative projects, review and pass upon the plans, specifications, and estimates therefor, inspect and approve the construction thereof, certify to work done, and periodically inspect and report on the subsequent maintenance and condition of the roads constructed; to carry on routine office business, including correspondence, maintenance of records and accounts, purchase of supplies and equipment, and other clerical work.

*Procedure.*—The procedure outlined in the act of July 11, 1916 (Federal-aid road act), and in the rules and regulations for carrying out the provisions of the act, as promulgated by the Secretary of Agriculture September 1, 1916, with amendments.

*Cooperation.*—States through their State highway departments.

*Location.*—Headquarters at Washington, D. C.; 10 district offices—Portland, Oreg., San Francisco, Cal., Denver, Colo., Minneapolis, Minn., Omaha, Nebr., Fort Worth, Tex., South Chicago, Ill., Montgomery, Ala., Troy, N. Y., and Washington, D. C.; and points in all the States as projects are approved.

*Date begun.*—1916.

*Results.*—The organization of Bureau of Public Roads has been extended to handle operations under the act, 10 district offices established, rules and regulations drafted and promulgated, and standard forms for plans and specifications prepared and promulgated. Every State in the Union has now enacted appropriate legislation and created highway departments with which effective cooperation may be had under the act.

*Assignment.*—L. W. Page, P. St. J. Wilson, J. E. Pennybacker, T. Warren Allen, E. W. James, and district engineers.

*Proposed expenditures, 1918-19.*—\$450,000 and the balances remaining from 3 per cent administrative allotments for the fiscal years 1917 and 1918.

#### NATIONAL-FOREST ROAD CONSTRUCTION.

##### Supervision:

*Object.*—To direct and supervise the survey, construction, and maintenance of roads and trails within or partly within the national forests, in accordance with the provisions of the act of July 11, 1916 (Federal-aid road act), and to carry on routine office business, including correspondence, maintenance of records and accounts, purchase of supplies and equipment, and other clerical work incident thereto.

*Procedure.*—The procedure outlined in the act of July 11, 1916, and the rules and regulations for carrying out the provisions of the act as promulgated by the Secretary of Agriculture.

*Cooperation.*—Forest Service.

*Location.*—Washington, D. C., district offices, the national forests, and immediately contiguous territory.

*Date begun.*—1916.

*Results.*—The preliminary organization of this project has been completed and the making of preliminary investigations, reconnoissance surveys, location surveys, and the construction of roads in or partly within the national forests have been carried on in Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Minnesota, Montana, Nevada, New Mexico, North Carolina, Oregon, South Dakota, Tennessee, Utah, Virginia, Washington, Wyoming, and Alaska.

*Assignment.*—P. St. J. Wilson, A. E. Loder, and district engineers.

*Proposed expenditures, 1918-19.*—\$84,580.

##### Construction and Maintenance:

*Object.*—To locate, survey, design, construct, and maintain roads, trails, and bridges within or only partly within the national forests when necessary for the use and development of resources upon which communities within and adjacent to the national forests are dependent.

*Procedure.*—Applications for cooperation in road construction are made to the Secretary of Agriculture through the district foresters of the Forest Service by the proper officers of the State or county concerned. The applications are examined, working plans for the several States prepared, terms of cooperation arranged with applicants, cooperative agreements executed by the applicants and by the Secretary of Agriculture, and allotments made to the several projects. When financial arrangements have



been made and cooperative agreements signed, the work of survey and construction is turned over to the Bureau of Public Roads for execution.  
*Cooperation.*—Forest Service, States, counties, and other local subdivisions of the States.

*Location.*—The national forests and lands contiguous thereto.

*Date begun.*—1916.

*Results.*—With a completed organization, the making of preliminary investigations, reconnoissance surveys, location surveys, and the construction of roads in or partly within the national forests have been carried on in Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Minnesota, Montana, Nevada, New Mexico, North Carolina, Oregon, South Dakota, Tennessee, Utah, Virginia, Washington, Wyoming, and Alaska.

*Assignment.*—P. St. J. Wilson, A. E. Loder, and district engineers, highway engineers, and others, as necessary.

*Proposed expenditures, 1918-19.*—\$900,000.

**Total, National-Forest Road Construction, \$984,580.**

**Total, Road Construction Under the Federal-Aid Road Act, \$1,434,580** (plus balances from 3 per cent administrative allotments from appropriations for the fiscal years 1917 and 1918).

[Regulation.]

## NATIONAL-FOREST ROAD CONSTRUCTION UNDER THE 10 PER CENT FUND.

### National-Forest Road Construction Under the 10 Per Cent Fund:

*Object.*—Preliminary examination, survey, design, construction, and maintenance of roads, trails, and bridges within the national forests.

*Procedure.*—Upon request from the Forest Service work is undertaken and carried on by the Bureau of Public Roads through the same organization and under substantially the same field and office procedure as the work under section 8 of the Federal-aid road act of July 11, 1916.

*Cooperation.*—Forest Service.

*Location.*—National-forest States and Alaska.

*Date begun.*—1912.

*Results.*—The making of preliminary investigations, reconnoissance surveys, location surveys, and design and the construction of roads within the national forests have been carried on in practically all of the national-forest States.

*Assignment.*—P. St. J. Wilson, A. E. Loder, and district engineers.

*Proposed expenditures, 1918-19.*—\$239,009 (\$16,000 for supervision of approved and unapproved projects and for engineering investigations in connection with unapproved projects; \$223,009 for survey and construction).



## BUREAU OF MARKETS.

### ADMINISTRATION.

#### General Administration:

*Object.*—Supervision of the investigational, demonstrational, service, and regulatory work of the Bureau of Markets and the execution of the necessary administrative work connected therewith.

*Location.*—Washington, D. C.

*Date begun.*—1913.

*Assignment.*—Charles J. Brand, chief of bureau; Herbert C. Marshall, assistant chief of bureau; Caroline B. Sherman, librarian.

*Proposed expenditures, 1918-19.*—\$22,750.

#### Operation:

*Object.*—To administer and supervise the business organization and operation of the Bureau of Markets, both in Washington and at the branch offices in the field.

*Procedure.*—The work of the Bureau of Markets is divided into four principal branches, viz, investigations and demonstrations, regulatory work, service work, and operation. The Branch of Operation is under the direction of the administrative assistant in charge of operation, who has charge of the general management of the business affairs of the entire bureau, including field offices. Specifically, the following lines of work, all of which are centralized, are conducted in the Branch of Operation: The appointment work; the selection and discipline of clerical and sub-clerical employees; the preparation of estimates, project statements, co-operative agreements, requests for leases and other contracts, and regular and special reports; the filing of correspondence; the viséing and mailing of outgoing and the opening and referring of incoming mail; the custody of supplies and equipment; the rental, assignment, and care of quarters in and out of Washington; the administrative examination of vouchers, authorizations, and requisitions; the addressing and duplicating work; the work of the stenographic section and of the photographic laboratory; the granting and recording of leave; all clerical and office work; the devising, adaptation, and standardizing of office methods and systems; and the other activities of the bureau as a business institution not coming under the heads of service or regulatory work, investigations, or demonstrations.

*Location.*—Headquarters, Washington, D. C.

*Date begun.*—1918.

*Assignment.*—R. V. Bailey, C. L. Snow.

*Proposed expenditures, 1918-19.*—\$105,355.

**Total, Administration,** \$128,105, including \$108,470 statutory (research, \$44,837; regulation, \$43,556; service, \$37,150; extension, \$2,562).

[Research.]

### MARKETING AND DISTRIBUTION.

#### Cooperative Purchasing and Marketing:

*Object.*—To investigate cooperative and semicooperative associations formed for the purpose of marketing and distributing or purchasing farm products and for the purchase of farm supplies, and to discover the forms of organization and methods of management best suited for their use.

*Procedure.*—Plans for the future involve a continuation of work conducted in the past, which has consisted of surveys of communities of producers and consumers to determine the practicability of using cooperative meth-



ods of grading, packing, inspecting, marketing, and distributing or purchasing farm products, in the purchase of farm supplies, and in utilizing or selling by-products of the farm; and rendering assistance in the organization of cooperative marketing and purchasing societies. Personal visits are made to organizations in various sections of the country to study their form of association and method of transacting business, in order to suggest any necessary improvements.

*Location.*—Washington, D. C.; field work in various sections of the United States as required.

*Date begun.*—1913.

*Results.*—(1) During 1918: Plans for cooperative marketing and purchasing associations were supplied to producers of all kinds of farm products in various parts of the United States, and personal assistance in organization problems was given to producers in 25 States. Among the products included were citrus and deciduous fruits, potatoes, onions, and other vegetables, honey, tobacco, dairy products, and broom corn. Assistance was also given to producers and consumers desiring to purchase supplies cooperatively.

Members of the project assisted in conducting farmers' short courses and similar gatherings in eight States, discussing and explaining cooperative organization matters.

The survey of cooperative purchasing and marketing associations was continued, a special study having been made of farmers' grain-elevator companies.

Publications issued during 1917: Department Bulletins—541, "Cooperative Organization By-laws," and 547, "Cooperative Purchasing and Marketing Organizations among Farmers in the United States"; Yearbook Separates—736, "Teamwork between the Farmer and His Agent," and 738, "Cooperative Marketing—Where? When? How?"; and Bureau of Markets Document 6, "Distribution and Utilization of the Garden Surplus."

(2) Prior to 1918: Practical surveys were made of producing communities for the purpose of assisting farmers to improve marketing methods and to organize. Assistance was rendered in the organization of cooperative associations in all parts of the country and in strengthening associations already formed. By-laws suitable for cooperative purchasing and marketing organizations were drafted. A proposed State cooperative law designed to conform to the Clayton Act was prepared in collaboration with the office of the Solicitor. A survey of cooperative purchasing and marketing organizations was undertaken and the results compiled.

Publications issued prior to 1918: Yearbook Separates—637, "Cooperative Marketing and Financing of Marketing Associations," and 658, "The Cooperative Purchase of Farm Supplies"; Farmers' Bulletin 656, "The Community Egg Circle"; Department Bulletin 302, "Apple Market Investigations, 1914-1915"; and Service and Regulatory Announcements 20, "Suggestions for a State Cooperative Law Designed to Conform to Section 6 of the Clayton Act."

*Assignment.*—O. B. Jesness, F. S. Ruggles, J. M. Mehl, Theo. Wade.

*Proposed expenditures, 1918-19.*—\$17,480.

### **Market Surveys, Methods, and Costs:**

*Object.*—To make comprehensive and detailed studies of the origin, movement, distribution, and consumption of market supplies of farm products, especially fruits and vegetables, in order to accumulate and disseminate useful information relating to all phases of the subject, including available and prospective production; movement of products into storage; the various agencies by and through which farm products are handled, distributed, stored, and sold; costs of doing business through existing market channels; and other matters. (See also "Collecting and Distributing Market Information.")

*Procedure.*—Information is accumulated to show the areas of surplus production of specific crops, dates within which certain areas move crops, usual markets to which crops are shipped, volume of movement in previous years, and tendency to increase or decrease production. Study is made of market methods, whether consignments, f. o. b. sales, or sales through private distributing organizations. At certain consuming cen-



ters accurate records are kept of receipts and prices of specific products, while sample shipments are traced from producer to consumer, an itemized account being kept of all charges, costs, profits, and losses. Investigations are conducted relative to sales of farm products through auction companies, and other matters. Monthly reports of cold-storage holdings of apples, butter, eggs, cheese, lard, frozen beef, cured beef, frozen pork, sweet pickled pork, dry salt pork, and frozen lamb and mutton are issued. (See "Transportation and Storage," "Marketing Dairy Products," and "Market Reports on Live Stock and Meats.")

*Cooperation.*—Informal cooperation with the Bureau of Crop Estimates; railroad companies, cold-storage warehouses, and others.

*Location.*—Washington, D. C.; in about 30 of the larger markets of the country; and in the most important shipping areas of the various perishable products, in succession.

*Date begun.*—1913.

*Results.*—(1) During 1918: Studies of the consuming capacities of the principal markets have been continued. Data covering the calendar year 1917 have been secured regarding the number of cars of apples, asparagus, cabbage, cantaloupes, celery, cherries, grapes, lettuce, onions, peaches, pears, sweet potatoes, Irish potatoes, strawberries, tomatoes, and watermelons unloaded at 24 of the principal markets of the country. Studies of the methods of marketing followed in the most important producing sections of the United States have been continued and enlarged, detailed reports having been prepared covering certain localities. These reports dealt with the methods of marketing 17 different perishable commodities. Postal-card reports of the shipments of over 80 commodities are being received from railroad station agents throughout the country. This information is tabulated so that it is possible to show at any time the number of cars of practically any perishable commodity moving out of any State or section of the United States. Publications: Department Bulletin 667, "The Origin of Carlot Shipments of Fruits and Vegetables in the United States in 1916."

(2) Prior to 1918: During the winter of 1916–17 data on marketing conditions in the apple districts of the Northwest were compiled and tabulated, and surveys were made in practically all the important peanut and bean producing sections. The postal-card reports mentioned above were commenced in 1916, and the studies of the consuming capacities of different markets were started in the fall of 1915. In 1915 cold-storage reports were begun covering apples. Publications: Department Bulletins—237, "Strawberry Supply and Distribution in 1914"; 266, "Outlets and Methods of Sale for Shippers of Fruits and Vegetables"; 267, "Methods of Wholesale Distribution of Fruits and Vegetables on Large Markets"; 290, "Rail Shipments and Distribution of Fresh Tomatoes, 1914"; 298, "Peach Supply and Distribution in 1914"; 315, "Cantaloupe Marketing in the Larger Cities with Carlot Supply, 1914"; 401, "The Marketing and Distribution of Western Muskmelons in 1915"; and 477, "Marketing and Distribution of Strawberries in 1915."

*Assignment.*—W. A. Sherman, Paul Froehlich, Julius Smith.

*Proposed expenditures, 1918–19.*—\$23,000.

### Market Grades and Standards:

*Object.*—To encourage and educate growers and shippers of fruits and vegetables to prepare their products for market properly, and to develop fixed grades and standards for universal use, with a view to the ultimate national standardization of market grades and packages or containers.

*Procedure.*—Studies are made of the present methods of handling, grading, packing, shipping, and inspecting farm products, and of existing types and sizes of boxes, baskets, hampers, crates, barrels, and other packages. The construction, equipment, and management of fruit and vegetable packing houses are studied to determine the plans and methods best suited to various crops and conditions. The work in the producing districts is accompanied by investigations in the markets to determine the requirements as to grade and containers. The study of the preparation and handling of apples, peaches, strawberries, potatoes, sweet potatoes, and onions will be continued and work on other fruits and vegetables undertaken.



*Location.*—Washington, D. C., and in the producing sections and their markets.

*Date begun.*—1913.

*Results.*—Bulletins dealing with the harvesting, grading, packing, and shipping of cantaloupes and potatoes have recently been published, and the necessary information has been secured and is being compiled for similar publications regarding apples, strawberries, peaches, and tomatoes. These bulletins describe the handling methods employed in the various producing sections and contain recommendations for improvements.

Satisfactory grades for apples, onions, sweet potatoes, Irish potatoes, and tomatoes have been determined. The recommended apple grade specifications have been enacted into law by several of the States. Recommendations for potato grades were published September 10, 1917, and their adoption was jointly urged by the Department of Agriculture and the United States Food Administration. As a result they have been widely accepted by growers and dealers as a basis for sale. The State of Texas recently adopted the bureau's proposed onion grades. The work under this project has included the explanation of the grade specifications to growers and dealers and the demonstration of grading methods. Special attention is being given at this time to the determination of the possibilities of using machinery for grading and handling various crops as a means of saving labor. Publications: Farmers' Bulletins—703, "Suggestions for Parcel Post Marketing"; 707, "The Commercial Grading, Packing, and Shipping of Cantaloupes"; 753, "Commercial Handling, Grading, and Marketing of Potatoes"; and 979, "The Preparation of Strawberries for Marketing"; Office of the Secretary Circular 48, "Marketing Maine Potatoes"; Bureau of Markets Documents—4, "Preliminary Report on Apple Packing Houses in the Northwest," and 7, "Potato Grades Recommended by the United States Department of Agriculture and the United States Food Administration"; and Service and Regulatory Announcements 28, "Food Products Inspection Law."

*Assignment.*—C. T. More, W. M. Scott, H. E. Truax, H. C. Hetzel, M. M. Stewart, T. W. Ayres, W. F. Allewelt, Manley Stockton, N. Menderson, F. E. Parsons, F. P. Downing.

*Proposed expenditures, 1918-19.*—\$27,820.

### **City Marketing and Distribution:**

*Object.*—To investigate the distribution and marketing of farm products in cities, in order to determine and encourage the practice of the best methods and to extend advisory aid to city authorities and other interested persons in establishing economical and efficient marketing facilities.

*Procedure.*—Personal investigations are made of various municipal and privately owned public wholesale and retail markets offering points worthy of study, particular attention being paid to factors which will aid in the work of designing and estimating the costs of markets of various types to answer the needs in different cities. With this information as a guide, proper methods of establishing such markets are worked out; also regulations for the management of establishments of this kind. Plans are prepared for market buildings and market places which, upon request, are modified to conform to conditions in different cities. Advice is given personally by representatives of the bureau, through correspondence, and in bulletins to cities interested in improving their marketing facilities. Work planned for 1919 involves a continuation of much that is now under way and includes the designing of approved systems for the successful administration of public markets; the formulation of model regulations; the design of market structures of various kinds and their equipment, which have not been treated heretofore; study of city ordinances relating to the marketing and distribution of farm products, with a view to suggest improvements; and special investigations of the service rendered by and the proper regulation of the huckster and push-cart systems in large cities. Studies are conducted regarding the losses which result from waste and deterioration due to the inefficient operation of established wholesale or retail agencies and their faulty location with reference to transportation agencies, consuming sections, etc.

*Location.*—Washington, D. C., and various cities throughout the United States.



*Date begun.*—1913.

*Results.*—(1) During 1918: Personal investigations were made and advice given in regard to the development or improvement of public marketing facilities in Chicago, Ill., Denver and Colorado Springs, Colo., Salt Lake City, Utah, Cleveland, Ohio, Lynchburg, Va., and in Oil City and Wilkes-Barre, Pa. Work was continued in connection with the development of an improved wholesale terminal produce market at Pittsburgh, Pa., where conferences have been held with produce dealers and railroad officials at which plans for terminal improvement were favorably discussed. Extensive correspondence was carried on with many other cities in which advice was given relative to improvements in local marketing conditions. Suggested forms for city ordinances covering the establishment and management of public farmers' markets have been worked out. At the request of the Census Bureau aid was given in the preparation and editing of schedules for a very complete survey of municipally owned public markets in cities having populations of 30,000 and more. Motion pictures were made showing municipal public marketing activities in a large number of northern and eastern cities, as well as the harvesting, grading, packing, and shipping of various farm products in New York State. Assistance was rendered in preparing mailing lists of more than 500,000 dealers for use in making the food survey of the United States. This project also cooperated in other ways in connection with the food survey.

(2) Prior to 1918: Since the project was begun in 1913 personal surveys relating to some phase of local marketing conditions have been made in about 35 cities throughout the country. In a number of these places marketing improvements have been carried out or plans for such improvements prepared in accordance with the recommendations given. Seven standard designs have been worked out for model public market buildings, market places, and the necessary accompanying equipment, in order that reliable information may be given to cities desiring to make marketing improvements. Upon request special adaptations have been made of these plans to meet local conditions in a number of cities. A survey of municipal marketing facilities has been made in all cities of 10,000 population or more.

*Publications:* Yearbook Separate 636, "Retail Public Markets"; Farmers' Bulletin 707, "The Commercial Grading, Packing, and Shipping of Cantaloupes"; and Bureau of Markets Document 6, "Distribution and Utilization of the Garden Surplus."

*Assignment.*—G. V. Branch, McFall Kerbey.

*Proposed expenditures, 1918-19.*—\$11,940.

(See also Supplement—Emergency Activities, p. 574.)

### **Transportation and Storage:**

*Object.*—To investigate the service furnished throughout the United States by common carriers of every kind in the transportation of farm products, particularly perishables; to ascertain the need for more and better service in individual sections and in connection with particular commodities, and to cooperate with shippers in securing and with carriers in inaugurating such service; by comparisons of service, to elevate the standard of all; to inform carriers as to the greater needs of shippers in transportation service, and to bring shippers to a better understanding of their rights, duties, and joint responsibilities with the carriers in the safe transportation of their products to the consumer; to cooperate with shippers and carriers in a campaign of education for the use of better packages and better methods of harvesting, packing, and loading, so as to reduce the present great economic loss of foodstuffs in transit; to encourage the proper construction of cold-storage houses wherever desirable; to determine accurately the amount, kind, and location of all available public storage space in the United States for foodstuffs (except grains), as well as its ownership and the rates charged for its use; to ascertain the points at which perishable foodstuffs are held in public storage and the relation of these points to producing sections, the length of time foodstuffs are so held, and the effect upon prices of holding them; and to issue reports regarding the cold-storage holdings of certain commodities, such as apples, butter, eggs, cheese, lard, frozen beef, cured beef, frozen pork, sweet-pickled pork, dry salt pork, and



frozen lamb and mutton. (See "Market Surveys, Methods, and Costs," "Market Reports on Live Stock and Meats," and "Marketing Dairy Products.")

*Procedure.*—The character of transportation service furnished at the present time is ascertained from carriers, and from shippers is determined what additional service is necessary or desirable. By personal conference, correspondence, and through bulletins the question of standardization and improvement of service is approached. Through the same channels and through attendance at and participation in conferences of representatives of shippers and carriers, the desirability of closer cooperation between the two is emphasized, and stress is laid upon the necessity for eliminating economic waste in transit. Information respecting storage space, commodities stored, and commodity prices as affected by storage is secured as far as possible from the operators of storage plants, supplemented by data secured from other sources, and reports are issued monthly (semimonthly during the producing season) regarding the cold-storage holdings of certain commodities.

*Cooperation.*—Bureaus of Plant Industry, Animal Industry, and Chemistry; Interstate Commerce Commission; U. S. Railroad Administration; U. S. Food Administration; storage houses, the meat and produce industry; associations of farmers and shippers; associations, bureaus, and committees of claim and traffic, and other officials of common carriers.

*Location.*—Washington, D. C., and in the field.

*Date begun.*—1913.

*Results.*—(1) During 1918: This project has secured from carriers a vast amount of statistical information regarding the origin, movement, and distribution of live stock, fruits, and vegetables. Heretofore data of this kind have never been available in such detail as to be of any real value. Arrangements were continued with the railroads for daily telegraphic reports in connection with the project "Market News Service on Fruits and Vegetables," and similar arrangements have been made for daily telegraphic reports in connection with the project "Market News Service on Live Stock and Meats." Efforts have been made to make more apparent to railroad officials the value to the carriers of the work of the Department of Agriculture and the desirability of closer cooperation between the department and the carriers. Complaints and appeals for assistance reaching the department with respect to transportation, due to the abnormal conditions created by the war, are handled by the Transportation Division with the railroads involved or with the office of the Director General of Railroads. Publications: Department Bulletin 458, "Handling and Marketing Durango Cotton in the Imperial Valley," and Yearbook Separate 701, "Possibilities of a Market Train Service."

(2) Prior to 1918: The principal features of the work of this project prior to 1918 were the arrangements which it consummated with carriers for telegraphic reports regarding shipments of fruit and vegetables and for mail reports (by originating stations) of carload shipments of fresh or dried fruits and vegetables. Publications: Department Bulletin 191, "Demurrage Information for Farmers."

*Assignment.*—G. C. White, I. C. Franklin, E. R. Gassman, W. M. Winter, F. M. Patton, J. J. Stevens, W. H. Seidel, R. E. Mason.

*Proposed expenditures, 1918-19.*—\$17,720.

(See also Supplement—Emergency Activities, pp. 572-573.)

### **Direct Marketing Activities:**

*Objects.*—To determine the feasibility, both from a physical and economic viewpoint, of marketing farm products by parcel post and by express from producer to consumer direct, and to ascertain the best methods to be used.

*Procedure.*—Experimental shipments are made with various commodities both to and from Washington. Employees in the field experiment in bringing producers and consumers into business contact for direct marketing. Field studies are made of the determining factors for the success or failure of parcel-post marketing campaigns conducted by postmasters in a number of cities. In cooperation with the States Relations Service, assistance in marketing farm products is rendered to girls' canning clubs in the South.



*Cooperation.*—Post Office Department, Bureaus of Chemistry, Animal Industry, and Plant Industry, and the States Relations Service.

*Location.*—Washington, D. C., Syracuse, N. Y., St. Louis, Mo., Columbus, Ohio, and points in various other States and sections of the country as may be found feasible in the development of the work.

*Date begun.*—1913.

*Results.*—(1) During 1918: A preliminary survey of direct marketing conditions and the possibility of extending the use of the parcel post for that purpose was undertaken in Syracuse, N. Y., with the cooperation of the Post Office Department. Eighty-four postoffices within the second parcel-post zone from Syracuse were visited and data obtained as a foundation for future work. Other preliminary surveys were made in territory surrounding Columbus, Toledo, and Cincinnati, Ohio, in cooperation with the Post Office Department, the Ohio branch of the Council of National Defense, and the State Director of Marketing of Ohio. A campaign for the encouragement of direct marketing, in cooperation with the Post Office Department and the Women's Central Committee on Food Conservation, was undertaken in St. Louis, Mo.

(2) Prior to 1918: A study was made of shipping eggs by parcel post in lots of less than 15 dozen. Experimental shipments by parcel post were made with many commodities, more than 10,000 pounds of butter having been involved. Field studies of parcel-post marketing were completed in Atlanta, Ga., Birmingham, Ala., New Orleans, La., Boston, Lynn, and Lawrence, Mass., Providence, R. I., Baltimore, Md., Portland, Oreg., Seattle and Tacoma, Wash., San Francisco, Los Angeles, and San Diego, Cal., and Fort Worth, Dallas, Galveston, Houston, San Antonio, and Austin, Tex.

*Publications:* Farmers' Bulletins—594, "Shipping Eggs by Parcel Post"; 703, "Suggestions for Parcel Post Marketing"; 830 (a revision of Farmers' Bulletin 594), "Marketing Eggs by Parcel Post"; 922, "Parcel Post Business Methods"; and 930, "Marketing Butter and Cheese by Parcel Post"; and Department Bulletin 688, "Marketing Berries and Cherries by Parcel Post."

*Assignment.*—Lewis B. Flohr, C. C. Hawbaker, F. D. McClure, H. A. Spilman.

*Proposed expenditures, 1918-19.*—\$11,840.

(See also Supplement—Emergency Activities, p. 575.)

### **Market Business Practice:**

*Object.*—To investigate the business practices of cooperative and farmers' marketing, distributing, purchasing, and rural business organizations and other marketing agencies, with special reference to their accounting systems and methods of auditing, business organization, and financing, and to devise suitable methods of business practice and accounting systems for these organizations and agencies for the purpose of increasing their efficiency.

*Procedure.*—Plans for the fiscal year 1919 include work necessary to perfect uniform systems of accounting for agencies employed in handling agricultural products on a commission basis, community canneries, small cooperative stores and selling organizations, credit unions, milk distributing plants, sweet-potato curing plants, and sirup packing plants. Investigations will be made regarding the accounting needs of cold-storage warehouses, cheese factories, cotton gins, flour mills, and tobacco warehouses. A study will be made of the economic principles involved in the operation of business units engaged in marketing farm products, in order to ascertain the sources of waste and to suggest means whereby the waste may be eliminated. Wherever practicable, workers on the project will act in an advisory capacity to farmers' and other marketing and distributing agencies throughout the United States which desire to improve their business practice and methods of accounting.

*Cooperation.*—Bureau of Animal Industry (Dairy Division) and various agricultural colleges, grain elevators, creameries, fruit and produce exchanges, commission houses, cold-storage warehouses, etc.

*Location.*—Washington, D. C., and various points in the field.

*Date begun.*—1913.

*Results.*—(1) During 1918: A system of accounting for fruit shipping organizations, particularly for those in the Pacific Northwest, has been



perfected and made available for use. An adaptation of the forms comprising this system has been made to meet the special requirements of tomato shipping organizations, and such forms were installed in the offices of the Florida East Coast Growers' Association and its affiliated organizations. Preliminary investigations have been made with respect to the accounting methods and business practices of community canneries, small cooperative stores and selling organizations, credit unions, milk distributing plants, sweet-potato curing plants, and sirup packing plants. A preliminary survey has been begun with a view to devise a system of cost accounting for cold-storage warehouses. A study was made of the comparative costs of operation in primary grain elevators, and this material has been submitted for publication in bulletin form. Investigations relating to accounting methods used by agencies engaged in handling agricultural products on a commission basis were continued, and the material gathered will be used as a foundation for devising a uniform system of accounts for commission houses.

(2) Prior to 1918: Uniform systems of accounts for country creameries, primary grain elevators, fruit shipping organizations, cooperative stores, live-stock shipping associations, and cotton warehouses were perfected and made available for use. Publications: Department Bulletins—178, "Cooperative Organization Business Methods"; 225, "A System of Accounting for Cooperative Fruit Associations"; 236, "A System of Accounts for Farmers' Cooperative Elevators"; 371 "Patronage Dividends in Cooperative Grain Companies"; 362, "A System of Accounts for Primary Grain Elevators"; 381, "Business Practice and Accounts for Cooperative Stores"; 394, "A Survey of Typical Cooperative Stores in the United States"; 403, "A System of Accounts for Live-Stock Shipping Associations"; 520, "A System of Accounts for Cotton Warehouses"; 559, "Accounting Records for Country Creameries"; and 590, "A System of Accounting for Fruit Shipping Organizations"; Bureau of Markets Document 2, "Lumber Accounting and Opening the Books in Primary Grain Elevators"; and Yearbook Separates—699, "A Federated Cooperative Cheese Manufacturing and Marketing Association," and 705, "Business Essentials for Cooperative Fruit and Vegetable Canneries."

*Assignment.*—B. B. Mason, G. O. Knapp, A. E. Warner, A. V. Swarthout, B. E. Corporon, E. J. Way.

*Proposed expenditures, 1918-19.*—\$29,580.

### **Foreign Market Investigations:**

*Object.*—To investigate foreign markets for American farm and non-manufactured food products, from the handling at the American seaboard to the distribution in foreign countries, and to assist so far as possible in the development of the export trade in such products; to investigate especially the export facilities at the American seaboard and beyond, the methods and costs of physically handling products intended for shipment abroad, transoceanic and foreign transportation, the methods of distribution and sale in foreign countries, their sources of supply, consumptive demand, trade practices and preferences, and the various competitive factors encountered abroad by American producers and shippers; incidentally to investigate successful foreign systems, cooperative and otherwise, for purchasing farm supplies and marketing farm products, including a study of representative consumers' organizations, municipal markets, and the conditions under which they have been developed; and to investigate the importation by the United States of farm and nonmanufactured food products.

*Procedure.*—So far as possible, basic information will be secured from exporters, freight brokers, forwarding agents, port corporations, and transoceanic shipowners or their agents in the United States. The project's investigations in foreign countries will be carried on through special agents and collaborators and by utilizing, so far as possible, the consular service and the services of the trade advisers of the State Department. The first problems to be studied will be those which are considered most pressing and which give the best promise of early results. Information will be secured and published regarding foreign trade opportunities, export shipping facilities, the physical conditions under which ship-



ments are forwarded, the costs incidental thereto, the methods of financing shipments, the normal foreign consumptive demand, the customs and preferences of foreign trade firms, their methods of distribution, and the causes of any dissatisfaction in foreign countries as to the condition, grade, and packing of American export farm and nonmanufactured food products. Information will be published regarding the importation of such products by the United States. American producers, shippers, and consumers will be aided by reporting to them information regarding foreign purchasing and marketing systems, cooperative and otherwise, and the causes of their success or failure.

**Cooperation.**—Various bureaus of the Department of Agriculture; the consular service and trade advisers of the Department of State; Bureau of Foreign and Domestic Commerce, Department of Commerce; National Foreign Trade Council; United States Chamber of Commerce; and interested growers' associations, trade organizations, shippers, and transportation companies.

**Location.**—Washington, D. C.

**Date begun.**—1916.

**Results.**—During the fiscal years 1917 and 1918 the work of the project has been largely a matter of preparation for the return of normal conditions. Several months were spent in Europe in 1917 making a preliminary survey of the conditions under which the investigations must be carried on and visiting the various trade organizations for marketing cotton, grain, etc., in the United Kingdom, France, Italy, Spain, and Switzerland.

During the fiscal year 1918, a special investigator was sent to the fruit markets of the Far East, visiting China, Japan, eastern Siberia, and the Philippines. The report of his investigations setting forth the possibilities of developing those markets for American fruit products will be published at an early date.

Another special investigator was sent to Australasia in March to study the possibilities of developing markets for American fruit products in those countries. He will devote attention also to the live-stock, meat, wool, and dairy industries of Australia and New Zealand.

In order to safeguard American producers and consumers against the importation of infected and deteriorated grain from Australia, where a large surplus has accumulated, the bureau recently sent an expert to investigate the supply and condition of Australian grain and to effect satisfactory arrangements for the proper selection and supervision of such supplies as may be purchased and shipped for American account.

Through the consular service the bureau undertook in the fall of 1917 a survey of the status of the live-stock industries in the European countries, the possible demands upon America for breeding stock after the war, the names of the European breeders and their associations, and other information of value to the American live-stock industry when providing Europe's post-war requirements. A number of reports have been received, and when all of the districts are heard from the information will be assembled in suitable form for publication. An investigation also was undertaken through the consular service relative to the supply, condition, and location of grain in Russia. No reports as yet have been received.

**Assignment.**—Clarence W. Moomaw.

**Proposed expenditures, 1918-19.**—\$14,000.

(See also Supplement—Emergency Activities, p. 576.)

### **Miscellaneous Problems in Marketing and Cooperation:**

**Object.**—To enable the Bureau of Markets to cooperate effectively with those governmental agencies already conducting investigations in the marketing of specific products; to take up the study of new lines of investigation relating to the preparation, handling, storage, and marketing of food products, and the organization of rural communities not specifically provided for under other projects.

**Location.**—Washington, D. C., and points in the field where necessary.

**Date begun.**—1914.

**Results.**—The principal activities under this project in 1918 were conducted in cooperation with other projects of the bureau. Prior to the fiscal year 1918 preliminary work under this project was done in es-



establishing the projects "Marketing Live Stock, Meats, and Animal By-Products," "Marketing Dairy Products," and "Marketing Grain, Hay, and Seeds." A report on "Prices of Wheat to Producers in Kansas, etc.," has been published as House Document 1271, Sixty-third Congress.

*Assignment.*—Charles J. Brand.

*Proposed expenditures, 1918-19.*—\$12,480.

### **Cotton Handling and Marketing:**

*Object.*—To investigate the commercial processes involved in the handling, marketing, and utilization of cotton, in order to make recommendations as to improvements and economies; to conduct investigational work in connection with the organization of communities of cotton growers for marketing their product; and to make experiments and demonstrations in order to show the advantages of growing cotton from pure seed in these communities.

*Procedure.*—Present methods of handling and marketing the cotton crop are investigated. Assistance is given to cooperative organizations in handling and marketing cotton. Studies are made to determine the value to growers of grading their cotton before sale. Experiments are made to ascertain the relative commercial value of pure-bred varieties of cotton. Primary market surveys are undertaken to determine geographical production and the quality and variety of cottons produced. Studies are also made of the possibility of a uniform tare for cotton bales, standard dimensions for gin boxes, the effect of various methods of ginning and compression upon cotton fiber, and other matters relating to better methods of handling and marketing cotton.

*Cooperation.*—Informal cooperation with the States Relations Service, the Bureau of Plant Industry, and several agricultural and mechanical colleges in the South.

*Location.*—Washington, D. C., and field investigations in all the cotton-growing States, particularly North Carolina, South Carolina, Arkansas, Arizona, Georgia, California, Oklahoma, Mississippi, and Texas.

*Date begun.*—1912.

*Results.*—(1) During 1918: During the fiscal year 1918 grading demonstrations and investigations were conducted in cooperation with the North Carolina Experiment Station as a continuation of the study of market conditions begun in 1915. Similar demonstrations and investigations of cotton grading were conducted in South Carolina, Mississippi, Arkansas, Oklahoma, Texas, New Mexico, Arizona, and California. In this work cotton was classed for the farmer before sale, suggested improvements in the methods of marketing made, and growers urged to organize on a community basis for the production of a superior variety of cotton and in order to market their cotton in even running lots of grade and staple. The importance of exercising greater care in ginning and storing cotton was explained. Market surveys were conducted at a number of points adjacent to towns where this work was being done. In conjunction with the project "Cotton Warehousing Investigations," a comprehensive study was made of gin sampling under both the Texas permanent warehouse law and the Arkansas warehouse, marketing, and gin-regulating law, in order to determine the feasibility of grading cotton by gin samples. Studies of the South Carolina warehouse act were conducted in cooperation with the State Warehouse Commission. In North Carolina a survey was made of the cotton mills to determine the character of cotton consumed by them, and a campaign was conducted to urge producers to grow the quality of cotton needed by the mills. Investigations of marketing cotton in the seed were continued in those States in which the practice is extensive.

(2) Prior to 1918: Definite assistance in handling and marketing cotton graded prior to sale was given to farmers' organizations in Arkansas, Arizona, South Carolina, Georgia, Mississippi, and Texas. Cooperation was maintained with the North Carolina Experiment Station in administering the State law providing for cotton grading work. Market surveys were conducted in practically all of the cotton States. Surveys were made of the Sea Island and other long-staple cotton markets and of primary market conditions. Publications: Department Bulletins—36, "Studies of Primary Market Conditions in Oklahoma"; 146, "Economic Conditions in the Sea Island Cotton Industry"; 311, "The Hand-



ling and Marketing of Arizona-Egyptian Cotton of the Salt River Valley"; 375, "Disadvantages of Selling Cotton in the Seed"; 457, "Relation between Primary Market Prices and Qualities of Cotton"; 458, "Handling and Marketing Durango Cotton in the Imperial Valley"; and 476, "A Study of Cotton Market Conditions in North Carolina with a View to Their Improvement"; Yearbook Separate 605, "Improved Methods of Handling and Marketing Cotton"; and Farmers Bulletins—764, "Cotton Ginning Information for Farmers," and 775, "Losses from Selling Cotton in the Seed."

*Assignment.*—Fred Taylor, D. E. Earle, O. J. McConnell, A. D. Hudson, J. H. H. Higginbotham, C. E. Atkinson, J. G. Martin, C. F. Currin.

*Proposed expenditures, 1918-19.*—\$19,900.

### **Cotton Warehousing Investigations:**

*Object.*—To accumulate and disseminate useful information relating to the warehousing of cotton, insurance rates while in storage, and benefits, including better arrangements for financing, to be derived from conserving cotton in storage houses, the construction of different types of warehouses, and the relation of present methods and practices of compressing cotton to warehousing. The work of this project is conducted in close cooperation with that done under "Administration of the United States Warehouse Act."

*Procedure.*—Study is made of the standards for cotton warehouses recommended by insurance underwriters' associations, including costs and adaptability. Special attention is given to State warehouse systems and to cooperative storage companies, with the view of aiding such systems and organizations where possible. Investigations are made to determine the relation of warehouse facilities to the financing of the cotton crop and the interest rates on money loaned on cotton, and the relation of the various methods and practices of compressing cotton to storage capacity, insurance rates, and economy in handling and transportation. These studies are made in the entire cotton belt, special attention being given to representative sections. Tests are made to determine to what extent exposure of baled cotton to adverse weather conditions affects its value and to determine the proper methods of drying, picking, or brushing damaged cotton with minimum loss and labor costs. In cooperation with the project "Market Business Practice," the system of accounts for cotton warehouses outlined in Department Bulletin 520 is installed in warehouses whose managers express a desire to use this system.

*Cooperation.*—Informal cooperation with the States Relations Service, State experiment stations, colleges of agriculture, private individuals, commercial companies, insurance companies, and others.

*Location.*—Washington, D. C., all the cotton-growing States, and places outside the cotton belt where cotton is centered and held in storage.

*Date begun.*—Work conducted under "Cotton Handling and Marketing" from the institution of that project in 1913 to July 1, 1915; established as a separate project on the latter date.

*Results.*—In 1918 information was secured regarding the location, name, capacity, construction, cost, insurance rates on stored cotton, charges for storage, loans on stored cotton, and interest rates. Reports have been received from many warehouses not previously reporting. This information has been incorporated in the tabulations and outline maps. The lists of warehouses have been revised frequently and kept up to date.

Exhaustive tests to determine the relative practicability of grading cotton from gin and cut samples have been made. Data regarding this matter are now being compiled and will be available for consideration in the near future. These tests appear to warrant the conclusion that the adoption of gin sampling would bring about marked economies. Tests conducted in cooperation with the project "Cotton Handling and Marketing," in order to determine the extent of the damage sustained by cotton under exposed conditions, have been continued.

Department Bulletin 520, compiled in cooperation with the project "Market Business Practice," containing a suggested system of accounts for the use on all cotton warehouses, together with printed specimens of the various forms referred to therein, was issued. Information on the subject of cotton warehouse operation and management has been compiled and will be available for publication within a short time.



Study of the State warehouse laws has been continued, and conferences have been held and advice given to State officials on this subject.

*Assignment.*—R. L. Nixon, R. L. Newton, J. P. Brown, J. M. Workman.

*Proposed expenditures, 1918-19.*—\$7,840.

### **Marketing Cotton Seed and Its Products:**

*Object.*—To investigate present methods of handling, marketing, and utilizing cotton seed and its crude products, with a view to suggest means whereby improvements may be made and economies effected, and to make studies regarding future trading, the establishment of standard grades, and the standardization of conditions under which cotton seed and its products are handled and stored.

*Procedure.*—Plans for future work involve the formulation of standards for cotton seed and linters, experimental crushings to determine the efficiency of different kinds of equipment and methods of handling. Studies are made of State and Federal laws regulating the cottonseed industry; the various methods of handling cotton seed on the farm, at the gin, in transit, and in storage, and the effect of these methods on the resulting product; the business organization of the cottonseed and oil industry, including buying and selling for future delivery, the organization and operation of cottonseed-oil mills by cooperative producers, and the utilization of cottonseed products; and the special methods of preparation necessary to meet the requirements of various markets. The utilization of the machinery of cottonseed-oil mills in expelling oil from peanuts and soy beans may be investigated in connection with the other studies carried on under this project.

*Cooperation.*—Informal cooperation with the Bureaus of Animal Industry, Plant Industry, and Chemistry, cottonseed buyers, manufacturers of cottonseed oil, State officials, and others.

*Location.*—Washington, D. C., and points in the field as required.

*Date begun.*—1914.

*Results.*—(1) During 1918: Studies were made of the handling and marketing of cotton seed to determine the amount of moisture, foreign matter, and damaged seed found in this product as marketed under normal conditions and the effect of these factors upon cottonseed standardization.

Oil mills, cottonseed chemists, and State and interstate cottonseed crushers' associations furnish complete records of analyses of cotton seed produced throughout the entire cotton belt. These data will be compiled and considered in connection with the formulation of proposed cottonseed standards.

The collection of samples of linters has been continued and a tentative series of linter standards prepared which has met with the general approval of practically all the cottonseed crushers' associations.

(2) Prior to 1918 studies were made of the conditions surrounding the marketing of cotton seed, of the oil and nitrogen content of different varieties grown on the same land, of containers for handling cotton seed, various methods for its utilization, and the operation of cottonseed-oil mills. Many samples of cotton were collected and ginned and the seed from each of these samples analyzed to compare the qualities of seed received at the gin.

*Assignment.*—Fred Taylor, C. F. Creswell, J. G. Barrows.

*Proposed expenditures, 1918-19.*—\$5,900.

### **Marketing Live Stock, Meats, and Animal By-Products:**

*Object.*—To conduct a thorough study of existing markets and methods of marketing live stock through the large central and small local markets, including transportation, yardage, sale, and delivery of live stock and the slaughter, packing, and wholesale and retail distribution of meat products and by-products derived therefrom; classification and grading of live stock and meats and wool; and other allied subjects, with the view of improving the methods and reducing the cost of marketing live stock, meats, and animal by-products. (See also "Market News Service on Live Stock and Meats.")

*Procedure.*—Surveys are made of the centralized live-stock markets of the United States, including their organization, facilities, methods, sources of supply and demand, and other features; the shipment of live stock



to market is studied; and the methods and costs of handling and distributing meats are investigated. Studies are made of local marketing methods and facilities, such as cooperative live-stock shipping associations, farmers' cooperative packing houses, municipal abattoirs, and the marketing of farm-prepared meats. Studies also are made of commercial conditions affecting the marketing of live stock, meats, and animal by-products. Standard classes and grades of live stock and meats are being formulated and steps taken toward the unification of such standards in different live-stock markets and consuming centers. Information is being gathered from tanners, dealers, and others relative to supplies, consumption, demand, and prices of the various classes and grades of hides. Information also is collected from manufacturers, dealers, wool growers, and others relative to supplies, consumption, demand, and prices of the various classes and grades of wool; and the development of uniform classes and grades of wool is in progress. This project also cooperates in the issuance of monthly reports showing the cold-storage holdings of certain commodities.

*Cooperation.*—Bureaus of Animal Industry, Plant Industry, and Chemistry, Forest Service, Office of Farm Management, States Relations Service, and Federal Trade Commission.

*Location.*—Washington, D. C., Baton Rouge, La., Knoxville, Tenn., Little Rock, Ark., St. Paul, Minn., Raleigh, N. C., St. Albans, Vt., College Station, Tex., and other points throughout the United States as required.

*Date begun.*—1914, as a part of the project "Miscellaneous Problems in Marketing and Cooperation."

*Results.*—(1) During 1918: Investigation of the organization, facilities, and methods of centralized live-stock markets of the United States has been continued in connection with the establishment and operation of the market news service on live stock and meats; and monthly reports of live-stock receipts, shipments, and local slaughter have been received from all the principal stockyards. Investigation of the methods and facilities pertaining to wholesale slaughtering and meat packing and the distribution of packing-house products has been continued with special reference to the physical features of the by-products phases of the industry. Studies of wholesale and retail prices of meats have been continued in connection with the market news service. The investigation of the methods and costs of marketing hogs with special reference to shrinkage in transit was continued and expanded to include cattle and sheep, this work being done in cooperation with the project "Food Supply Investigations" and the Federal Trade Commission. The investigation of local marketing in the South was continued in a survey of marketing problems in southwestern Virginia; and, in cooperation with the State agents in marketing, attention was directed to the study and demonstration of the value of cooperative sales and shipments in the marketing of live stock. As in previous years, assistance was rendered to a number of communities desiring information relative to the establishment of local packing houses, and in connection with the investigation of methods and costs of marketing live-stock data were collected on the cost of obtaining killer stock by cooperative packing houses. In connection with the market news service, attention has been directed to the market classification and grading of meats in order to assist in unifying the standards in different live-stock markets and consuming centers. A complete file of wool dealers and manufacturers has been compiled for the purpose of obtaining reports on stocks and consumption of wool. An extensive beginning has been made in collecting a set of samples of the various classes and grades of wool with a view to establish uniform grades for this product.

(2) Prior to 1918: The results of a comprehensive study of the methods and costs of marketing live stock and meats were prepared for publication. Slaughter tests were made on certain lots of live stock, followed by studies of the distribution of the meat products and by-products resulting therefrom, and in connection therewith studies of wholesale and retail prices of meats were made. The marketing of live stock in the South, the organization and methods of cooperative live-stock shipping associations, and the farmers' cooperative packing-house movement were investigated. The municipally owned abattoirs in the United States were subjected to systematic study with reference to local market con-



ditions. A conference and hearing relative to the marketing of live stock and the distribution of meats were conducted by direction of the Secretary of Agriculture on November 15 and 16, 1915, at Chicago, under the chairmanship of the chief of the Bureau of Markets. Publications: Office of the Secretary Report 113, "Methods and Costs of Marketing Live Stock and Meats"; Farmers' Bulletins—809, "Marketing Live Stock in the South," and 718, "Cooperative Live Stock Shipping Associations"; and House Document 855, "Proceedings of the Conference Relative to the Marketing of Live Stock, Distribution of Meats, and Related Matters."

*Assignment.*—Louis D. Hall, A. G. Bovay, C. A. Burmeister, G. H. Dacy, M. Y. Griffin, H. W. Metzger, C. V. Whalin, G. T. Willingmyre, T. R. H. Wright.

*Proposed expenditures, 1918-19.*—\$32,400.

### **Marketing Dairy Products:**

*Object.*—To conduct a thorough study of the marketing of dairy products and dairy substitutes, including the agreements under which they are sold, the methods and costs of preparing dairy products for market, grades and classification of dairy products, quotations and quotation systems, market requirements, conditions, methods, and facilities, and related subjects, in order to suggest measures by which market conditions and marketing methods may be improved and the cost of marketing dairy products reduced. (See also "Market News Service on Butter, Cheese, Eggs, and Poultry," under Emergency Activities, p. 570.)

*Procedure.*—Descriptive and statistical information is being secured in surveys of the dairy producing sections and leading dairy markets of the United States. These surveys are supplemented by more detailed studies of the various phases of the whole problem of marketing dairy products. In these studies information and data are obtained through cooperating agencies, collaborators, correspondence, and questionnaires, and also through personal investigations by marketing specialists and assistants. Plans for 1919 involve a more detailed study of milk marketing and milk-marketing organizations, including the marketing of milk, cream, and other dairy products through producers, cooperative marketing associations, and other agencies. Particular consideration will be given to the methods of business management and operation followed by producers and other dairy-marketing associations and to the market classification, grading, and inspection of dairy products. Whenever practicable, assistance will be rendered to persons and organizations desiring to improve marketing methods and conditions. This project cooperates in the issuance of the monthly reports of the cold-storage holdings of dairy products. (See "Market Surveys, Methods, and Costs" and "Transportation and Storage.")

*Cooperation.*—States Relations Service, Bureau of Animal Industry, and agencies engaged in the production, manufacture, transportation, storage, marketing, and distribution of dairy products.

*Location.*—Washington, D. C., and points in the field where dairy products are produced, distributed, or consumed.

*Date begun.*—1914, as a part of the project "Miscellaneous Problems in Marketing and Cooperation."

*Results.*—Comprehensive surveys have been made of the marketing of creamery butter and American cheese in the larger distributing markets and in the more important producing sections of the United States and Canada and of milk-marketing methods and conditions in the larger cities and market-milk producing areas of the United States. In cooperation with various State agencies, a number of investigations have been made of the marketing of dairy products.

As the direct result of the surveys and investigations made, the following publications have been issued: Circular 66 of the Office of the Secretary, "Suggestions for the Manufacturing and Marketing of Creamery Butter in the South"; Department Bulletins—456, "The Marketing of Creamery Butter"; 639, "Market Milk Business of Detroit, Michigan"; 690, "Marketing Practices of Wisconsin and Minnesota Creameries"; and 682, "A Study of Prices and Quality of Creamery Butter"; and Farmer's Bulletin 930, "Marketing of Butter and Cheese by Parcel Post."



*Assignment.*—Roy C. Potts, Leon M. Davis, Gustave P. Warber, Delos L. James, Warren H. Barber.

*Proposed expenditures, 1918-19.*—\$18,820.

### Marketing Grain and Hay:

*Object.*—To investigate the primary and terminal marketing of grain and hay, including the cost of marketing, comparison of services rendered by independent and line elevators and cooperative purchasing and selling associations, future transactions and exchange practices, scalping, prices, market quotations, supply and demand, export trade, and related subjects, in order to suggest possible improvements and economies in marketing the grain and hay crops.

*Procedure.*—Field investigations are conducted regarding the methods and costs of marketing grain and hay at producing centers and terminal and retail markets. A study is being made of marketing methods adapted to certain sections and conditions, including methods of marketing special crops, such as grain sorghums and broom corn.

*Cooperation.*—Bureaus of Plant Industry and Crop Estimates and States Relations Service.

*Location.*—Washington, D. C., and points in the field as necessary.

*Date begun.*—1915.

*Results.*—(1) During 1918: The investigational work of this project has been continued in cooperation with the project "Food Supply Investigations" and the grain and hay market reporting service. The work has covered the various factors involved in the marketing of grain and hay at terminal and primary markets.

(2) Prior to 1918: A general survey was made of marketing grain at country points and a detailed study of terminal marketing undertaken. A special study of methods of distribution and marketing in the Eastern and Southern States also was made and assistance rendered in the Southern States in the marketing of corn, oats, and grain sorghums. A summary of grain-marketing conditions at country points has been published in Department Bulletin 558, "Marketing Grain at Country Points."

*Assignment.*—George Livingston, C. S. Cole, K. B. Seeds, V. E. Butler.

*Proposed expenditures, 1918-19.*—\$12,700.

### Marketing Seed:

*Object.*—To investigate (1) methods and cost of marketing; (2) services rendered and methods followed by various seed-marketing agencies; (3) methods of keeping records of seed stocks in their course from producer to consumer, in order to identify the stocks as to origin; (4) relation of prices received by producers and those paid by consumers; (5) methods of assessing dockage; (6) market quotations; (7) factors other than production affecting supply and demand; (8) relations of vegetable-seed production to seed-marketing agencies; (9) forms of advance growing contracts; (10) factors affecting quality and germination of seeds in handling, storage, transportation, and marketing; (11) cleaning methods and machinery; and (12) exports and imports of seeds.

*Procedure.*—Investigations of the methods of marketing seeds are made by personal trips to the most important producing and consuming sections. Samples of country-run seed are collected, and the prices at which they are being purchased from growers by country shippers, by representatives of seedsmen, and by others are noted. The quality and prices of country-run seed are compared with the quality and prices of recleaned seed as offered by seedsmen. Statistical information is obtained from all seed-marketing agencies through personal inquiries, market quotations, and price lists and by means of schedules and formal inquiries.

*Cooperation.*—Bureaus of Plant Industry and Crop Estimates and States Relations Service.

*Location.*—Washington, D. C., and points in the field as necessary.

*Date begun.*—1916.

*Results.*—(1) Prior to 1918: The most important field-seed producing areas in the Middle West were visited and detailed studies made of the various channels through which seed passes from the farmer to the seedsman. The services rendered by the country shipper, by the small



retail seed dealer, and by the large wholesale or retail mail-order seed house were observed and records made for reference in future investigations. The keeping of stock records, equipment and cleaning methods, standard samples, quotations, etc., were given careful consideration at the time of visiting seed establishments.

(2) During 1918: Several important seed distributing points in the South were visited and a comparison made between the methods of marketing in that section and in the North. The time of greatest fall and spring movement of seeds to consumers in the South was noted. Samples of country-run and recleaned country lots, together with lots offered by seedsmen at concentration or large distributing points in the Southwest, Northwest, and Pacific Northwest have been collected. The quality and prices of seed represented by these samples have been compared with each other and with those obtained from the previous year to determine the relation between these two factors in different localities and in different years. Studies have been made of grades and transactions in seed on the Toledo market. It is planned to enlarge upon this work and cover other important seed markets.

*Assignment.*—W. A. Wheeler, G. C. Edler.

*Proposed expenditures, 1918-19.*—\$14,760.

### **Preservation of Fruits and Vegetables in Transportation and Storage:**

*Object.*—To determine the effect on the keeping qualities of fruits and vegetables of commercial methods and facilities used in harvesting and preparing them for shipment and the amount of deterioration superinduced by the conditions under which they are stored and transported, in order to demonstrate improved methods of and facilities for harvesting, precooling, loading, refrigeration in transit, transporting, and storing such commodities, so as to insure a minimum of deterioration and decay.

*Procedure.*—The methods used in picking, hauling, grading, cleaning, packing, loading, shipping, and storing and in the handling processes which take place in terminal markets are carefully observed, in order to determine the relation of such operations to the keeping qualities and merchandising condition of fruits and vegetables. Experimental lots of fruits and vegetables are picked, packed, shipped, and stored properly, and their behavior in transit and storage is compared with the behavior of comparable lots of fruits and vegetables handled according to ordinary commercial methods. Studies are made to determine the stage of maturity at which fruits and vegetables should be picked to insure their arrival on the market in good merchandising condition and of the relation of maturity to keeping quality of fruits and vegetables in either common or refrigerated storage. The relation to keeping quality of precooling, or prompt cooling prior to shipment, is studied in various sections where conditions make the utilization of precooling plants practicable. The transportation of fruits and vegetables in refrigerator or ventilator cars is studied to determine the relation of car construction to deterioration of fruits and vegetables in transit. Extensive investigations are under way to determine accurately the methods of loading fruits and vegetables which should be used to prevent breakage and deterioration in transit and of the maximum number of packages that can be loaded with safety in refrigerator cars. The protection of perishable shipments from frost damage in transit is being studied, in order to determine the quantity of insulation, car modifications, and methods of constructing, installing, and operating car heaters necessary to furnish adequate protection against freezing in transit. Investigations are conducted to determine the physical factors governing successful preservation of vegetable plant products, whether in common or refrigerated storage.

*Cooperation.*—Bureaus of Plant Industry and Chemistry.

*Location.*—Washington, D. C., and points in the principal regions where fruits and vegetables are produced in commercial quantities.

*Date begun.*—This project was begun in the Bureau of Plant Industry in 1901. In the agricultural appropriation act for 1919 the work was transferred from the Bureau of Plant Industry to the Bureau of Markets.

*Results.*—(1) During 1918: Investigations of the methods of handling and transporting cantaloupes and small fruits have demonstrated the practicability of materially reducing serious losses of such products both in transit and at the market.



Refrigerator-car investigations have demonstrated that the average refrigerator-car equipment is not adequate for the safe transportation of perishable products. Approximately 7,000 or 8,000 cars are now being built in accordance with the recommendations of the department. One company alone is building 2,700 new and improved cars and is remodeling its old equipment, consisting of over 10,000 cars.

As a result of this work, the methods of loading many fruits and vegetables have been standardized and the losses from breakage and deterioration reduced. Practicable methods of protecting various fruits and vegetables from freezing have been worked out, making possible the prevention of serious losses now occurring annually.

Investigations relative to the construction and management of common storage houses for apples and potatoes have resulted in the improvement of such houses and in the construction and reconstruction of many such houses in accordance with department recommendations. The investigations relative to the handling of apples and other fruits, as well as vegetables, have been continued with good results.

(2) Prior to 1918: Orange-handling investigations in California effected savings to growers, and the lemon-handling investigations in that State, which resulted in many changes in methods, have been of assistance in eliminating wastes and losses. Investigations of the handling and storing of California grapes resulted in the development of the drum sawdust package and the redwood-sawdust method of packing. Prior to these investigations no grapes had been shipped in this way. At the present time 400 to 500 cars are shipped so each season. This method of packing made possible the extension of the marketing season for many varieties of grapes by three months or more. Investigations in handling and storing berries, cantaloupes, apples, pineapples, lettuce, and other commodities were attended with good results.

*Assignment.*—H. J. Ramsey, C. W. Mann, A. W. McKay, G. L. Fischer.

*Proposed expenditures, 1918-19.*—\$27,320.

(See also Supplement—Emergency Activities, pp. 572-574.)

**Total, Marketing and Distribution,** \$322,900, including \$30,660 statutory and \$17,400 lump-fund reserve.

[Service.]

## TELEGRAPHIC MARKET NEWS SERVICES.

### Market News Service on Fruits and Vegetables:

*Object.*—To collect and distribute by telegraph, mail, or otherwise, timely information on the supply, commercial movement, disposition, and market prices of fruits and vegetables, in order to assist in securing a better distribution of perishable products. (See also "Market News Service on Fruits and Vegetables," under emergency activities.)

*Procedure.*—A field force has been organized to cover in turn the most important producing areas of each fruit and truck crop immediately preceding and during its shipping season. Temporary and permanent branch offices have been established in the most important markets and consuming centers. Daily telegraphic reports are obtained from the common carriers of the number of cars of each crop shipped from producing areas on their lines, with destinations. These reports, together with the number of cars offered and prices prevailing on each of the principal markets, are summarized for redistribution to producing districts, markets, and the press.

*Cooperation.*—Weather Bureau, States Relations Service, railroad companies, boat lines, cooperative organizations, and growers, shippers, and receivers of perishable products.

*Location.*—Headquarters, Washington, D. C.; permanent market stations in Atlanta, Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Columbus, Denver, Des Moines, Detroit, Fort Worth, Houston, Indianapolis, Jacksonville, Kansas City (Mo.), Los Angeles, Memphis, Minneapolis, New Orleans, New York, Oklahoma City, Omaha, Philadelphia, Pittsburgh, St. Louis, Spokane, Butte, Fargo, Portland (Oreg.), San Francisco, and Seattle; and temporary offices in over 80 producing sections of the United States.



*Date begun.*—1915.

*Results.*—(1) During the calendar year 1917 four series of reports relating to fruits and vegetables were issued as follows: Daily carlot shipments and jobbing-price reports on fruits and vegetables, weekly and semiweekly summaries of carlot shipments, weekly market reviews, and the consumers' news service. Of the first type 9,394,689 reports were distributed during the year, including, in their season, daily reports upon apples, asparagus, beans, bunched and mixed vegetables, cabbage, cantaloupes, celery, cranberries, grapes, grapefruit, lettuce, onions, oranges, peaches, spinach, strawberries, pears, sweet potatoes, tangerines, tomatoes, watermelons, and Irish potatoes. Semi-monthly reports on honey were issued. This service was given continuously from April 1, 1917.

(2) The preliminary work in 1915 and the spring of 1916 was conducted under the project "Market Surveys, Methods, and Costs." During the first year of this service (1915) four commodities were reported on and in 1916 nine commodities.

*Assignment.*—Wells A. Sherman, O. W. Schleussner, J. W. Fisher, R. M. Peterson, Julius Smith, H. B. Daly, George B. Fiske, H. P. Henry, Clyde H. Heard, Benjamin Jelinek, Albert E. Mercker, Dudley Alleman, Edward J. Ransick, John J. Ahearn, G. Lincoln Barber, William H. Hall, J. Harold Hoover, George M. Meyer, Robert L. Ringer, E. D. Baker, B. C. Boree, T. C. Bushfield, Charles W. Chewning, Saxon D. Clark, Harold J. Clay, Elbert E. Conklin, George E. Engels, Paul Froehlich, A. D. Gail, jr., J. C. Gilbert, H. A. Harris, Phil C. Isbell, Bernard B. Jones, C. W. Kitchen, Frederick R. Keebler, Walter Kingsbury, J. P. Klein, Russell L. Lepper, Albert E. Lindquist, O. J. McDonald, L. Herbert Martin, Willard H. Mosier, F. W. Read, Clifford R. Runyan, E. M. Seifert, jr., Ralph M. Rutledge, Wayne M. Stevens, Edwin W. Stillwell, W. B. Walker, H. H. Warner, M. S. Wiggins, E. R. Biddle, J. K. Boyd, Louis J. Case, Don E. Crews, E. B. Gustafson, W. J. Hildebrandt, William P. Johnson, F. W. Kern, R. S. Lumbard, E. D. McNulty, H. E. Munger, P. J. Roach, Wm. R. Thawley, Wm. G. Thompson, C. B. Tubergen, B. E. Yaden, Wm. H. Stanton, Jos. H. Else.

*Proposed expenditures, 1918-19.*—\$265,600.

(See also Supplement—Emergency Activities, p. 570.)

### **Market News Service on Live Stock and Meats:**

*Object.*—To gather and compile data concerning supplies, prices, and distribution of live stock, meats, and other animal products, and on related subjects, and to publish this information at such frequent intervals as will most effectively guide producers, consumers, and distributors in the sale and purchase of such products.

*Procedure.*—Information is gathered from stockmen, live-stock associations and agricultural boards, common carriers, stockyards, commission firms, live-stock exchanges, slaughtering and meat-packing companies, meat dealers, and others relative to the numbers and movements of marketable live stock in live-stock feeding districts and growing sections; daily railroad loadings of live stock throughout the United States, with State origins and market destinations; receipts, shipments, demand, and prices of live stock at market centers; daily supplies, demand, and prices of meats and meat food products in the principal distributing centers, and related data.

Daily reports on meat-trade conditions and prices at the principal distributing centers and live-stock loadings on railroads; weekly reports, reviews, and summaries on current live-stock and meat-trade information; and monthly reports of receipts, shipments, and slaughter of live stock at stockyards and of stocks of meats are transmitted by leased wire to the various branch offices of the project, where they are promptly released and widely distributed.

This project also cooperates in the issuance of monthly reports showing the cold-storage holdings of frozen and cured meats, lard, frozen poultry, and eggs.

*Cooperation.*—Bureaus of Crop Estimates and Animal Industry and Weather Bureau.

*Location.*—Headquarters, Washington, D. C.; local offices at Boston, Mass. New York City, Philadelphia, Pa., Chicago, Ill., Kansas City, Mo., and Omaha, Nebr.



*Date begun.*—1916.

*Results.*—(1) During 1918: The work done in 1917 was continued and expanded. The live-stock loading report service was extended to include the entire United States. The monthly "live stock at stockyards" report was expanded to include the total shipments and the local slaughter at stockyard centers. A weekly bulletin containing items and summaries of current market information pertaining to demand, supplies, movements, and distribution of live stock and meats is being issued. A report showing the stocks of the various commercial classes and grades of foreign and domestic wools held by manufacturers and dealers is issued quarterly. A report showing the consumption of wool is issued each month.

(See also "Market News Service on Live Stock and Meats," under emergency activities, p. 570, and project, "Marketing Live Stock, Meats, and Animal By-Products.")

(2) Prior to 1918: A market news service on meat-trade conditions in eastern consuming centers was instituted in December, 1916, and the information was published daily in bulletin form in Boston, New York, Philadelphia, Chicago, Omaha, Kansas City (Mo.), and Washington. The reports were distributed free to all who requested them. The railroads throughout the United States furnished statements as to the number of cars of each class of live stock loaded at every station on their lines in 1916, and some of them furnished similar information for 1915. Daily telegraphic reports were received from division superintendents of railroads, showing State origins, destinations, and the number of cars of each class of live stock loaded during the preceding 24 hours. This information was compiled daily and wired to the principal central markets. Monthly reports showing the receipts and shipments of live stock at all the stockyard centers in the United States, including some 60 points, were received. Through cooperation with the Bureau of Crop Estimates, plans were perfected by which the crop reporters of that bureau made estimates as to the relative supply of marketable live stock of various classes on hand in each county in the United States.

*Assignment.*—Louis D. Hall, E. V. Baker, Stephen Bray, C. A. Burmeister, W. C. Davis, S. W. Doty, W. O. Ellis, W. M. Fisk, C. E. Gibbons, John P. Mead, J. H. Peters, S. H. Ray, D. J. Slater, A. B. Smeby, C. V. Whalin, G. T. Willingmyre, T. R. H. Wright.

*Proposed expenditures, 1918-19.*—\$90,740.

(See also Supplement—Emergency Activities, p. 570.)

**Total, Telegraphic Market News Services, \$356,340, including \$101,760 statutory.**

[Research.]

## FOOD SUPPLY INVESTIGATIONS.

### Food Supply Investigations:

*Object.*—To make investigations relating to the production, transportation, storage, preparation, marketing, manufacture, and distribution of agricultural food products, including the extent, manner, and methods of any manipulation of the markets or control of the visible supply of such food products, or any of them, by individuals, groups, associations, combinations, or corporations.

*Procedure.*—An investigation of the cost of producing live stock, begun in cooperation with the Office of Farm Management, will be continued and extended. An investigation of the cost of moving stock from farms and ranges to centralized markets also will be continued with special reference to methods of handling which will reduce the labor involved and the shrinkage and loss in transit. A comprehensive study will be made of the methods and practices which prevail in handling stock at stockyards and at centralized markets to determine what economies may be made, especially in saving grain and other feed. The relative economy of marketing stock through public abattoirs, country packing plants, and centralized markets also will be investigated further, special attention being given to the basis for prices paid at different points, in order to determine the influence of centralized markets on country selling. The costs of handling stock in the packing plants located at the large cen-



tralized markets and the relative efficiency in handling by-products at these and country packing plants will continue to be considered, in cooperation with the Federal Trade Commission. A comprehensive study will be made of the methods and costs of handling meat by the retail trade.

A comprehensive, intensive study is being made of country elevators in the principal grain-producing sections of the United States, in order to determine the economic importance and efficiency of the various types of elevators, also the fluctuation of prices at competitive points compared with noncompetitive points. These data should serve as a basis for further study of terminal practices and functions.

Price fluctuations will be investigated to determine whether caused by crop or car shortage, weather conditions, combinations, speculation, etc.

The facts will be determined concerning the wastes of specific products which are commonly alleged to occur in some sections simultaneously with shortages and higher prices for the same products in other regions. Reliable information will be secured regarding the cause of the differences between prices received by the producer and those paid by the consumer. Records and analyses should be made in typical cases of the charges that accrue in all steps of the processes of marketing and distributing agricultural food products in order to locate and identify the items which collectively constitute this difference.

*Cooperation.*—Bureaus of Animal Industry and Crop Estimates and the Office of Farm Management, of the Department of Agriculture; Bureaus of the Census and Foreign and Domestic Commerce, of the Department of Commerce; Federal Trade Commission, State and city boards of health, State Department, consular services, Interstate Commerce Commission, and the Federal Shipping Board.

*Location.*—Headquarters, Washington, D. C.; investigations to be conducted within and throughout the United States, as necessary.

*Date begun.*—1917.

*Results.*—Records of the shipment of live stock from points of origin in Kansas, Montana, Wyoming, Colorado, and almost every State in the corn belt have been obtained by investigators who have followed the shipments, recording the costs and noting conditions involved from shipping point to market. Many data also have been obtained from the records of farmers, live-stock dealers, and live-stock shipping associations relative to the cost of marketing stock and the shrinkage in shipment. In cooperation with the Federal Trade Commission, a special study has been made of the by-products phase of the packing industry and the data prepared for publication.

Partial records have been obtained from nearly 500, and complete records from over 100 country elevators. Intensive study has been made of terminal conditions and practices and accurate records compiled from the books of commission firms, wire houses, and terminal elevators in Kansas City (Mo.), Minneapolis, and Chicago.

*Assignment.*—Charles S. Cole, George Livingston, L. D. Hall.

*Proposed expenditures, 1918-19.*—\$50,200, including \$1,400 statutory.

[Service.]

## MARKET INSPECTION OF PERISHABLE FOODS.

### Market Inspection of Perishable Foods:

*Object.*—To investigate and certify to shippers and other interested parties the quality and condition of fruits, vegetables, and other perishable farm products when received at important central markets.

*Procedure.*—Inspections are made at the request of interested parties, usually before cars are unloaded. Certificates are issued concerning the quality and condition of the products inspected. Rules and regulations governing the procedure to be followed in requesting and making inspections are contained in Circular 82, Office of the Secretary, "Rules and Regulations of the Secretary of Agriculture under the United States Food Products Inspection Law." Additional information regarding this subject is contained in Service and Regulatory Announcements of the Bureau of Markets No. 28.

*Location.*—Washington, and important central markets, such as Atlanta, Baltimore, Boston, Buffalo, Butte, Chicago, Cincinnati, Cleveland, Council



Bluffs, Dallas, Denver, Des Moines, Detroit, Fargo, Fort Worth, Galveston, Houston, Indianapolis, Jacksonville, Jersey City, Kansas City (Mo.), Los Angeles, Memphis, Minneapolis, New Orleans, New York, Oklahoma City, Omaha, Philadelphia, Pittsburgh, Portland (Oreg.), Providence, San Francisco, Spokane, St. Louis, and St. Paul.

*Date begun.*—November 1, 1917, under funds made available by the food-production act.

*Results.*—This service has been established in 41 markets, 10 of which are served by inspectors in adjacent places. The certificates issued have afforded a satisfactory basis for the settlement of disputes between shippers and receivers, as shown by the prompt release of cars used for transporting produce and by a substantial decrease in the number of rejections of shipments of produce by the dealers.

The service has been welcomed by growers, shippers, receivers, and the transportation companies—in fact, by all parties interested in the distribution and marketing of farm products. So great has been the demand for inspections that it has not been possible to train men and institute the work rapidly enough to meet it. Since the inauguration of the service practically all the fruits and vegetables loaded on naval supply ships at New York for the use of the Navy, as well as the purchases for the Great Lakes Naval Training Station near Chicago, have been inspected.

At the request of the Quartermaster's Department of the Army, certain Army camps and cantonments situated in the neighborhood of inspection points have been visited by inspectors, who have been assisted by the camp quartermaster in making inspections of the purchases of fruits and vegetables, and several inspectors have been assigned to the inspection of Army supplies in the producing sections. The work of the inspectors has been of material value to the United States Food Administration in connection with the enforcement of the rules and regulations governing licensees.

*Assignment.*—W. M. Scott, C. T. More, E. L. Markell, H. C. Hetzel, O. W. Schleussner.

*Proposed expenditures, 1918-19.*—\$114,200, including \$1,200 statutory.

(See also Supplement—Emergency Activities, p. 574.)

#### [Research.]

### INVESTIGATIONS AND DEMONSTRATIONS OF COTTON STANDARDS, AND COTTON TESTING.

#### Investigations and Demonstrations of Cotton Standards:

*Object.*—To make field and laboratory investigations and demonstrations of standards for the different grades, qualities, and conditions of cotton, and to investigate the ginning, grading, baling, stapling, marking, compressing, and tare of cotton. (The actual preparation and distribution of the cotton standards established under the provisions of the United States cotton-futures act is carried on under another project.)

*Procedure.*—Studies are made regarding the adaptability to trade conditions of the standards for grade of white cotton and those for tinged and stained cotton. Methods are being considered for determining the exact length of staple of cotton, in order to prepare a standard for this quality. Necessary work is being done to complete the preparation of the standards for Arizona-Egyptian cotton. A further study will be made of the various grades, qualities, and conditions of cotton, with the object of establishing standards for cotton of perished staple, immature staple, and for gin-cut and reginned cotton. The physical effects of the various processes of ginning, baling, and compressing on the grade and fiber of cotton are being investigated. When practicable, the services of grading experts are furnished to communities of cotton growers in order to demonstrate and promote the use of the official cotton standards. This work is done in conjunction with the "Cotton Handling and Marketing" project. To the end that cotton quotations may be placed on a more uniform basis, grade and standardization demonstrations will be conducted in certain spot markets for cotton.

The investigational and clerical workers assigned to this project also assist with the projects formed to conduct work in the enforcement of the United States cotton-futures act and in the field investigations in cotton handling and marketing.



*Cooperation.*—States Relations Service; cotton gins and growers, interior buyers, cotton brokers, factors, compresses, cotton mills, and agricultural colleges.

*Location.*—Laboratory work at Washington, D. C.; field work where necessary.

*Date begun.*—1907.

*Results.*—(1) During 1918: The investigations regarding the tentative standard grades of Egyptian cotton grown in the Salt River Valley of Arizona were continued and a sufficient quantity of stock selected for the preparation of 50 tentative sets of standards for distribution to the trade in order to determine their practicability by use during the next season. The increasing acreage planted to cotton in Arizona each season and the large demand for this cotton from the automobile-tire industry add to the importance of this work. Study of standards for the various lengths of staple has been continued and tentative length standards from  $\frac{7}{8}$ , 1,  $1\frac{1}{8}$ ,  $1\frac{1}{4}$ , and  $1\frac{3}{8}$  inch have been prepared. A stock of cotton is being selected for the preparation of a number of tentative standards representing the Georgia and Florida Sea Island cotton. Owing to the advent of the boll weevil in the Sea Island district and the experimental introduction of new varieties, it will be necessary to make further investigations and await more normal conditions before attempting the official promulgation of standards applicable to this crop. During the month of December, 1917, 15,000 bales of Sea Island cotton were classed for the Signal Corps at Savannah, Ga., and Jacksonville, Fla., such classing being based upon the tentative standards mentioned above. In connection with the project "Cotton Testing," investigations have been made to determine the effect upon cotton fiber of the various forms of compression, ranging from 15 pounds per cubic foot to 35 pounds per cubic foot. Investigations to date indicate that the higher compression may be used without injury to the fiber.

(2) Prior to 1918: The standards which now represent white cotton were promulgated December 14, 1914, as the official cotton standards of the United States. After detailed investigations and study standards for tinged and stained cotton were officially promulgated on January 28, 1916. (A list of the standards so far promulgated may be found under "Enforcement of the United States Cotton-Futures Act: Preparation and Distribution of the Official Cotton Standards of the United States.") In order to preserve the integrity of the official standards, 25 sets of the white standards promulgated December 15, 1914, and 10 sets of the standards for tinges and stains promulgated January 28, 1916, have been stored in vacuum tubes. These tubes will be opened whenever necessary to check the accuracy of future work. During the past year cotton samples were collected from all parts of the cotton belt and from manufacturing shippers in order to assemble the types recognized by the trade as having a specified length of staple. These samples were carefully classed and the results compiled for use as a guide in establishing a set of tentative standards which may be officially promulgated at a later date if found representative and fair to all branches of the trade.

*Assignment.*—Fred Taylor, George Butterworth, F. E. Devine, H. C. Slade, H. B. Richardson.

*Proposed expenditures, 1918-19.*—\$18,960.

### Cotton Testing:

*Object.*—To ascertain the waste, tensile strength, and bleaching qualities of the different grades, classes, and varieties of cotton, in order to determine their commercial and spinning value and to demonstrate the results of such tests.

*Procedure.*—Spinning tests are conducted in cooperation with textile schools in various localities and several of the large cotton manufactories in New England. These tests are made on the basis of the official cotton standards of the United States, representing cotton with staple approximately fifteen-sixteenths of an inch in length, purchased from representative sections of the cotton belt. Cotton of grades based upon tentative standards for Egyptian cotton grown in the Salt River Valley of Arizona is being tested in order to determine its suitability for use in the manufacture of airplane and balloon fabric. Parallel tests also are



being conducted on the tentative grades for Sea Island cotton and on Sakellaridis Egyptian cotton in order to determine the relative merits of each for the manufacture of airplane and balloon fabrics. The yarns and cloths manufactured will be tested for tensile strength, propensity for stretching, and mercerization properties. The amount of waste obtained from each grade during process of manufacture will be ascertained.

In cooperation with the Bureau of Plant Industry, tests will be made to determine the relative manufacturing properties of certain varieties of cotton, especially those having a fiber of less than seven-eighths of an inch in length as compared with the superior varieties of cotton with longer staple.

*Cooperation.*—Bureau of Plant Industry. United States Signal Corps. Bureau of Standards, cotton mills, manufacturers, and textile schools.

*Location.*—Spinning tests at Fall River and New Bedford, Mass., Raleigh N. C., and in other localities; laboratory work at Washington, D. C.

*Date begun.*—1913.

*Results.*—(1) During 1918: The results of the spinning tests on the official cotton standards of the United States representing white cotton were compiled and demonstrated that the waste content of the highest grade, middling fair, was 6.30 per cent, while that of the lowest grade, good ordinary, 14.41 per cent. Other results of considerable interest and importance to the trade were developed during the course of these tests and are being published in bulletin form.

Spinning tests also were made at the New Bedford Textile School on the tentative standards of Arizona-Egyptian cotton prepared by the department. The results of these tests to date show that these standards will meet the requirements of the trade adequately. The Pima variety of Arizona cotton is being tested in order to determine its merits for the manufacture of airplane and balloon fabric, as compared with the merits of Sea Island and Sakellaridis Egyptian cotton for the same purpose. Owing to the scarcity of linen it is now necessary to use large quantities of extra staple cotton in the manufacture of these fabrics, and the uncertainty of the Sea Island production makes it desirable to find other suitable stocks for this purpose.

Spinning tests on varieties of Upland cotton have been made for the purpose of demonstrating the superiority of certain varieties over the so-called "Half-and-Half" variety, which is a prolific cotton of poor character and short fiber.

Spinning tests on cotton compressed to various densities showed that it may be safely compressed to a density of 35 pounds per cubic foot without injury to the fiber. The department, therefore, is urging that cotton be compressed to a density of 35 pounds per cubic foot, during the present emergency at least, in order to utilize shipping and tonnage space more efficiently. The results of these compression tests are now in course of publication.

Department Bulletin 591. "Manufacturing Tests of the Official Cotton Standards of the United States for White Cotton," has been published.

(2) Prior to 1918: Tests comparing the qualities of certain selected long-staple Upland varieties with those of certain well-established varieties grown in the Mississippi Delta showed the former to be superior in some respects. Tests made in cooperation with the Federal Horticultural Board on foreign-grown cotton fumigated with hydrocyanic-acid gas have demonstrated that such fumigation does not damage the cotton fiber. Comparative spinning tests showed that the Egyptian cotton grown in the Salt River Valley of Arizona is practically equal to Sea Island and Egyptian cotton of similar grade and staple.

Spinning tests of the Pima and Yuma varieties of Egyptian cotton showed that, while the waste percentages were higher in the Pima, the breaking strength of each variety was practically the same. However, the production of Pima is superseding Yuma because of its greater productiveness and longer fiber and also because it is easier to pick.

*Assignment.*—Supervisory committee: Fred Taylor and D. E. Earle; G. H. Anderson, R. V. Hellams, C. E. Killingsworth.

*Proposed expenditures, 1918-19.*—\$32,900.

**Total, Investigations and Demonstrations of Cotton Standards, and Cotton Testing, \$51,860, including \$5,940 statutory.**



[Research.]

**RURAL COOPERATION.****Rural Credit, Insurance, and Communication:**

*Object.*—To aid in solving problems relating to the organization of rural communities for the purpose of obtaining better credit, insurance, and communication facilities by the accumulation and dissemination of useful information relating to the various phases of the subject.

*Procedure.*—Field investigations, supplemented by returns from questionnaires, personal correspondence, and by the study of official and other records, are made of the following subjects: The existing successful agencies extending mortgage and personal credit to farmers; organized activity among farmers for credit improvement; financing the breeding, feeding, and marketing of live stock; the uses and abuses of store and machinery credit; the problem of farm finance on reclamation projects in the West; various crop liens and leasing and tenancy systems; legislation affecting mortgage and personal farm credit; the nature and extent of losses in agriculture and the facilities most helpful in reducing such losses or minimizing such risks; how efficient facilities for agricultural insurance may be best established and conducted; and organization for the improvement of methods of rural communication, especially between farms and in relation to local markets.

*Cooperation.*—Informal cooperation with Bureaus of Plant Industry, Animal Industry, and Crop Estimates, the States Relations Service, Federal Farm Loan Board, State agricultural colleges, various State departments, and local agencies.

*Date begun.*—1913.

*Results.*—(1) During 1918: A comprehensive investigation of current interest rates paid on long and short time farm loans has been made in the United States. Credit needs of farmers in the drought-stricken areas west of the Mississippi River were investigated, a statement embodying the results of this investigation being published in the Federal Reserve Bulletin of December 1, 1917. A study of credit unions has been made, and a special study looking toward the preparation of credit statements for use by bankers in extending short-time farm loans is under way. A preliminary investigation has been made of facilities for financing the live-stock business. Field studies of various types of farmers' mutual insurance companies have been continued. A digest has been made of the State laws relating to farmers' mutual fire-insurance companies and a model State law for such companies is in tentative form. Work has been done in cooperation with the project "Market Business Practice" in devising an accounting system for farmers' mutual fire-insurance companies. Further study has been made of local telephone companies and systems in 20 States. Service and Regulatory Announcements No. 30, "Suggestions for an Act Providing for Cooperative Credit Associations or Credit Unions," has been published.

(2) Prior to 1918: Information was given to a number of States and to Congress regarding legislation affecting rural credits. Comprehensive information relative to the extent of the advancing business from merchants to farmers in the 10 cotton States was tabulated and summarized. Information was gathered concerning plans of organization of farmers' mutual insurance companies in the United States, financial conditions on reclamation projects, and farmers' telephone companies. Model forms for articles of incorporation and by-laws for farmers' mutual fire-insurance companies and wind-storm insurance companies were completed. Publications: Farmers' Bulletins—593, "How to Use Farm Credit"; 654, "How Farmers May Improve Their Personal Credit"; and 792, "How the Federal Farm Loan Act Benefits the Farmer"; Office of the Secretary Circular 60, "Amortization Methods for Farm Mortgage Loans"; Department Bulletins—384, "Costs and Sources of Farm Mortgage Loans in the United States"; 409, "Factors Affecting Interest Rates and Other Charges on Short-Time Farm Loans"; and 530, "The Organization and Management of a Farmers' Mutual Fire Insurance Company"; and Yearbook Separates—675, "How the Department of Agriculture Promotes Organization in Rural Life," and 697, "Farmers' Mutual Fire Insurance."



*Assignment.*—C. W. Thompson, V. N. Valgren, L. E. Truesdell, R. L. Bennett, W. L. Wanlass.

*Proposed expenditures, 1918-19.*—\$24,000.

### Rural Social and Educational Activities:

*Object.*—To aid in the improvement of social and educational conditions in rural communities by the accumulation and dissemination of useful information growing out of a study of typical communities with reference to their social and educational needs, the work of their existing forms of organization, and the possibilities for improvement through organized activity; to investigate methods of encouraging social organization activities; and to study means of improving social, economic, and educational conditions of women and children through the work of women's rural organizations.

*Procedure.*—Experimental studies are made for the improvement of county and community fairs. Assistance is given in conducting local community surveys. A general survey of women's rural organizations is being made. Methods of financing and operating community buildings are studied.

*Location.*—Washington, D. C., and various points in the field.

*Date begun.*—1913.

*Results.*—(1) During 1918: A study has been made of national and State associations among farmers. The study of methods of financing, maintaining, and managing community buildings has been continued. Data concerning 110 such buildings have been gathered. The special study of successful women's rural organizations has been continued. Publications: Farmers' Bulletin 870, "The Community Fair," and Yearbook Separate 726, "Rest Rooms for Women in Marketing Centers."

(2) Prior to 1918: Social, economic, and community surveys were made in Chilton County, Ala., Orange County, N. C., and Albemarle County, Va. Model forms for articles of agreement and by-laws for rural community clubs and lists of national and local women's organizations interested in social and educational activities were prepared. Data from a survey of the granges in Ohio were tabulated. A list of annual county and community fairs held in the United States was compiled. Publications: Yearbook Separates—626, "The Organization of Rural Interests," and 632, "The Organization of a Rural Community."

*Assignment.*—C. W. Thompson, J. S. Moran, W. O. Nason.

*Proposed expenditures, 1918-19.*—\$10,880.

**Total, Rural Cooperation, \$34,880, including \$6,600 statutory.**

[Research and Extension.]

## STATE COOPERATION IN MARKETING WORK.

### State Cooperation in Marketing Work:

*Object.*—To enable the Department of Agriculture to cooperate effectively with the several States in the employment of agents to study methods of marketing and distributing farm products; to encourage, guide, and assist in coordinating marketing activities undertaken by the various States; and to carry to the people of the States selected for cooperation under this project, by demonstration or otherwise, the results of the investigations of the department relative to the marketing and distribution of farm products.

*Procedure.*—This work is carried on, in cooperation with certain of those States which appropriate money for marketing purposes, through the employment of specialists or agents in marketing and such other assistants and facilities as may be necessary. These agents maintain headquarters in the various States concerned, and their salaries and expenses are borne jointly by the Federal Government and the States. As joint representatives of the two agencies, they correlate and unify the marketing activities of both, making available to each the facilities and potentialities of the other.

*Cooperation.*—States Relations Service and agricultural colleges, State boards of agriculture, and other State, county, or municipal agencies.

*Location.*—Arkansas, Colorado, Connecticut, Georgia, Indiana, Iowa, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Mon-



tana, Nebraska, New Mexico, North Carolina, Ohio, Oregon, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, and Washington.

*Date begun.*—1916.

*Results.*—To July 1, 1918, field work has been carried on in 30 of the 48 States. The appointment of additional men in the other States is taking place from time to time.

Surveys of the marketing facilities for principal agricultural products have been undertaken in the 27 States with which cooperative agreements have been made. A survey of the marketing facilities of Maricopa County, Ariz., has been completed and a report is being prepared for publication. Data relative to the agricultural resources of the San Juan Basin, Colo., were collected. Surveys of the marketing of poultry products have been made in Tennessee and Colorado; of dairy products, in Colorado, Mississippi, Oregon, and Vermont; of peanuts, in Georgia, South Carolina, and Virginia; of hemp, in Kentucky; of broom corn, in Colorado and New Mexico; of live stock, in Colorado, Iowa, Louisiana, North Carolina, Tennessee, Vermont, and Virginia; of wool, in Vermont; of potato-storage houses, in Tennessee and Utah; of sweet-potato storage, in Louisiana; of food consumption, in Massachusetts; of losses from overloading cars with perishables, in Colorado; of purchasing and marketing associations, in Arkansas, Connecticut, Indiana, Michigan, and Washington; of the bulk handling of potatoes and the value of potato associations, in Oregon; of the storage of potatoes, in Tennessee; of the grading, packing, and marketing of tomatoes, in Tennessee; of the market situation for canned fruits and vegetables, in South Carolina; of beans, in New Mexico; of velvet beans, in Georgia; of onions, in Indiana; of vegetables, in North Carolina; of fruit, in North Carolina; of the harvesting, grading, and marketing of apples, in Georgia and Michigan; of cherries, in Michigan; of berries, in Indiana; of cantaloupes, in Indiana; of maple products, in Vermont; and of public markets, in Washington.

Assistance has been given in the formation or strengthening of cooperative marketing associations as follows: Beans, Colorado and Montana; soy beans, Kentucky; cantaloupes, Kentucky; hemp, Kentucky; vegetables and fruits, Connecticut; strawberries, South Carolina; potatoes in irrigated districts, Montana; cabbage, New Mexico; live stock, Georgia and Iowa; grain-elevator associations, Iowa; tobacco marketing associations, Connecticut and Kentucky; cooperative purchasing of hay, Montana; cooperative purchasing and marketing associations, Michigan, Oregon, South Carolina, Tennessee, Vermont, and Washington; cooperative buying and selling of seeds, feeds, and fertilizers, Vermont; creameries, Vermont; cotton marketing associations, Oklahoma; canneries, South Carolina; an accounting and auditing association was formed and an expert accountant was appointed to demonstrate the value of uniform systems of bookkeeping in Montana.

In Georgia instructions were given in the grading of Irish and sweet potatoes. In Minnesota short courses were held for elevator managers and for those interested in creamery bookkeeping and accounting systems. In Nebraska courses were given in elevator accounting. In North Carolina instructions were given regarding cotton grading; in South Carolina, regarding the grading and packing of asparagus; and in Tennessee, regarding the grading of potatoes, tomatoes, and fruit. In Utah demonstrations were made in developing a market for beans, in drying fruits, and in the operation of a municipal market. In Virginia a campaign for the purpose of getting farmers to store staple farm products was conducted so as to supply local market demands. In Georgia, at the State fair, displays were made showing containers and methods of grading and packing potatoes and apples. Mississippi creamery butter was exhibited at the National Farm and Live Stock Show at New Orleans. A storage and container exhibit was made at the Utah State Fair, and an apple week was promoted at Salt Lake City. Vermont products were shown at the Eastern States Exposition at Springfield, Mass.

Individuals and associations have been assisted by bringing producers in touch with consumers. Shippers have been advised regarding customs and requirement of various markets and how to obtain information



concerning freight rates, train service, etc. Carload shippers have been put in touch with the Bureau of Markets inspection service; communities given assistance in working out special marketing problems; suggestions made relative to the grading, packing, and standardization of farm products; shippers advised of near-by market for canned goods; reliable information relative to the supply, demand, and prices of specific agricultural products in certain markets at definite times collected and disseminated; surplus seeds, feeds, and other farm products in the United States listed and information disseminated relative thereto; lists of growers, millers, dealers, and buyers of farm supplies, packing plants, independent buyers, live-stock dealers, shippers, wholesale grocers, commission men, etc., furnished upon request; vegetable warehouses listed and information collected concerning the construction, capacity, etc., for the benefit of producers and buyers; assistance given in the installation of uniform accounting systems; reports on cold-storage holdings compiled and distributed; and assistance rendered in connection with the market news service in Colorado, Connecticut, Georgia, Iowa, Kentucky, Louisiana, Massachusetts, Michigan, Mississippi, Oregon, South Carolina, North Carolina, and Utah.

*Assignment.*—J. C. Skinner, R. H. Elsworth, B. C. Moomaw, jr., W. L. Beers, C. E. Brehm, W. R. Camp, H. M. Eliot, H. C. Filley, L. G. Foster, M. C. Gay, M. H. Greene, Asher Hobson, Chas. S. Jones, Hector Macpherson, O. J. McConnell, Joseph McEvoy, C. A. McNabb, William L. Machmer, Robert W. Merrick, L. G. Mulholland, F. Rebotka, Elliott C. Rogers, G. C. Smith, S. L. Sweet, M. R. Tolstrup, J. H. Tull.

*Proposed expenditures, 1918-19.*—\$65,580, including \$4,080 statutory (research, \$13,116; extension, \$52,464).

[Research.]

## GRAIN STANDARDIZATION AND GRAIN HANDLING AND TRANSPORTATION INVESTIGATIONS.

### Investigation and Determination of Grain Standards:

*Object.*—To investigate such phases of harvesting, handling, transportation, storage, and grading of grain as contribute information fundamental and necessary for establishing, fixing, and perfecting standards for corn, wheat, rye, oats, barley, grain sorghums, flaxseed, and such other grains as the usages of the trade may warrant and justify; the relations of grades and standards to the feeding and manufacturing value of sound and unsound grain; the milling and the manufacturing value of wheat and such other grains as are used in the manufacture of flour, meal, and cereal products; smut and smut control in so far as this factor has to do with the commercial grading of wheat; and the influence on grade of biophysical, biochemical, and physiological changes which take place in grain during harvesting, transportation, and storage; to develop and perfect laboratory methods for determining the condition and quality of grain, and to devise and perfect special apparatus for use in grain grading.

*Procedure.*—The information already available will be compiled and brought into immediate service for use in establishing grades for grains for which standards have not been fixed. This information is being supplemented by field studies of such phases of harvesting, handling, transportation, and storage of grain as contribute information useful in perfecting old and establishing new standards from time to time for promulgation by the Secretary of Agriculture.

*Cooperation.*—Various bureaus and offices of the department, State agricultural experiment stations, and producers, shippers, dealers, and other agencies handling and inspecting grain, including the common carriers.

*Location.*—Washington, D. C., and points in the field. Research laboratories are maintained at the important grain marketing centers. (*See administration project, "Enforcement of United States Grain-Standards Act."*)

*Results.*—Data have been collected and a bulletin is now being prepared for publication to show in detail the grain storage and milling capacity of the entire United States. A bulletin on the bleaching of oats with



sulphur dioxide has been prepared for publication. Milling experiments and baking and dockage tests to determine the applicability of the Government grain standards to commercial conditions have been made and the information gained as a result of these tests used in making modifications in the standards. Work preliminary to the establishment of standards for oats has been practically completed and tentative standards submitted to the various agencies affected for criticism as to their practicability in the different grain marketing sections.

The presence of black and misshapen galls in commercial quantities of wheat has been studied. This disease results from the infection of wheat heads by the nematode *Tylenchus tritica* and was first observed at a comparatively recent date. Experiments relative to its distribution and its effect on market grades and milling quality have been made, and the results of these investigations are now in course of publication. The effect on the commercial grade of shelled corn and the conditions resulting from a heavy percentage of moisture in an abnormally large portion of the corn crop are being studied.

Experiments have been made to determine the shrinkage of rough rice in country warehouses, the amount and value of rice lost by poor threshing, and the milling values of rice. The results of these tests have been made available for the benefit of the rice industry. Special investigations of the grading factors of milled rice were made at New Orleans.

In cooperation with the Bureaus of Chemistry and Plant Industry, investigations have been made to determine the best methods of separating smut spores from wheat at the time of threshing, and apparatus developed and applied in practical tests has successfully eliminated a large amount of smut from wheat, thus improving its commercial value and limiting the spread of smut. A large number of threshing machines will be equipped with this apparatus during the coming year.

*Assignment.*—J. W. T. Duvel, S. A. Regan.

*Proposed expenditures, 1918-19.*—\$88,790.

### **Grain Handling and Transportation Investigations:**

*Object.*—To investigate general and specific commercial problems connected with the handling, transportation, and storage of grain, including methods employed on the farm, at the country elevator, and at distributing and consuming centers; the effect of shrinkage, drying, bleaching, mixing, dockage, cleaning, and handling on commercial value and market practice; the relation of transportation facilities to the economical and efficient marketing and distribution of grain in domestic and foreign commerce; the construction and equipment of elevators and warehouses in their relation to the efficient and economical handling, transportation, and storage of grain; and the investigation of such other related subjects as may furnish information useful to the various agencies engaged in the handling, transportation, storage, and merchandising of grain.

*Procedure.*—Field studies are made of the general and specific problems involved in the handling and transportation of grain, special attention being given to methods adapted to certain sections and conditions, including the handling, transportation, and storage of special grain crops. The results of such investigations will be compiled and published in the most convenient form for the use and information of those interested in the handling and transportation of grain.

*Cooperation.*—Producers, shippers, and handlers of grain and other agencies interested in the problems under consideration, including the common carriers.

*Location.*—Washington, D. C., and points in the field.

*Date begun.*—1916.

*Results.*—A bulletin has been prepared regarding country elevators, their various types, methods of construction, equipment, and facilities, and the methods of handling grain which should be employed by them. The handling of grain throughout the Pacific Northwest has been studied. The importance of this work is emphasized by the shortage of sacking material, which makes it imperative that the whole system of handling grain in the Pacific Northwest be modified by substituting bulk handling for the method generally in vogue. Largely as a result of this work,



many elevators have been constructed for the purpose of handling grain in bulk and will be ready for the 1918 wheat crop in Oregon, Washington, and Idaho. In Oregon alone about 50 new elevators are nearing completion, and in these three Northwestern States nearly 100 new grain elevators are in process of construction. These elevators are being constructed of concrete and wood and will have an average capacity of about 60,000 bushels each.

*Assignment.*—J. W. T. Duvel George Livingston, and S. A. Regan, jointly in charge.

*Proposed expenditures, 1918-19.*—\$25,320.

**Total, Grain Standardization and Grain Handling and Transportation Investigations, \$114,110, including \$21,360 statutory.**

[Regulation.]

## ENFORCEMENT OF THE STANDARD-CONTAINER ACT.

### Enforcement of the Standard-Container Act:

*Object.*—The object of this legislation, as stated in the act itself, is "to fix standards for climax baskets for grapes and other fruits and vegetables, and to fix standards for baskets and other containers for small fruits, berries, and vegetables, and for other purposes."

Sections 1 and 3 of the act establish mandatory standards for climax baskets for use in interstate commerce. Section 1 prescribes three capacities, 2-quart, 4-quart, and 12-quart, for climax baskets and fixes the dimensions of these three standard sizes. Sections 2 and 3 establish for use in interstate commerce standards of capacities for all other baskets and containers for small fruits, berries, and vegetables. Section 2 establishes the dry one-half pint, dry pint, dry quart, and multiples of the dry quart as the standards of capacity for such baskets in interstate commerce and fixes the contents of such baskets in cubic inches. Section 2 also restricts the use of containers larger than one dry quart for these products to sizes which are multiples of the dry quart.

The act further provides that it is unlawful to manufacture for shipment in interstate commerce, to sell for shipment in interstate commerce, or to ship in interstate commerce either empty or filled climax baskets or other baskets or containers which do not comply with this act.

Reasonable tolerances and variations are allowed in the rules and regulations promulgated by the Secretary of Agriculture.

*Procedure.*—Fruit and vegetable containers are tested; Government agents visit factories, markets, and producing sections to determine the kind of packages in use and to collect samples. Those affected by the law are being informed of its purposes and provisions by means of letters, bulletins, and articles in newspapers and magazines.

*Cooperation.*—Informal cooperation with the Bureau of Chemistry, Department of Agriculture, and Bureau of Standards, Department of Commerce.

*Location.*—Headquarters, Washington, D. C.; field work throughout the United States as necessary.

*Date begun.*—1917.

*Results.*—The law has been satisfactorily enforced since it went into effect on November 1, 1917. Hundreds of packages of various kinds which have been sent to the Bureau of Markets by manufacturers, dealers, and growers or collected by Government agents in the markets and producing sections have been tested to determine whether they complied with the provisions of the act.

Since the law meets with general favor, there have been few instances where it has been deliberately disobeyed. Practically all the manufacturers and dealers availed themselves of the time allowed to dispose of the packages that did not conform to legal requirements and are now cooperating willingly by submitting for testing and inspection samples of the packages made and used by them.

*Assignment.*—C. T. More, W. M. Scott, F. T. Downing.

*Proposed expenditures, 1918-19.*—\$5,000.



[Research.]

**MILLING AND BAKING INVESTIGATIONS.****Milling and Baking Investigations:**

*Object.*—To investigate the milling and baking qualities of wheat and other grains for the purpose of determining the relation to intrinsic values of such factors, as test weight per bushel, gluten content, color, texture, general appearance, different forms of damage, mixtures of different kinds and qualities of the same grain and of different grains, admixtures of various impurities, various treatments to which grain is subjected in commercial handling, storing, and milling, with the view of establishing and revising grading for these grains.

*Procedure.*—Milling and baking tests will be conducted upon samples and lots of grain to determine the relative values of different wheats and other grains, and the relation to milling and baking qualities of the various factors which are or should be recognized as affecting the value of the grain when inspected and graded for commercial purposes. The milling experiments will be conducted under such controlled conditions as will give the most comparable and consistent results with the different kinds, qualities, and grades of grain.

The results of this experimental work will be utilized in connection with the establishment and revision from time to time of the official grain standards of the United States and in other ways and will be made available, through publication, to grain producers, shippers, elevator men, warehousemen, millers, and bakers, in order that their practices in growing, shipping, storing, mixing, milling, and baking may be so arranged as to secure maximum returns from the various grains.

This project is under the joint general control and direction of a committee consisting of the chief of the Bureau of Markets, the chief of the Bureau of Chemistry, and the chief of the Bureau of Plant Industry.

*Cooperation.*—Bureaus of Chemistry and Plant Industry.

*Location.*—Washington, D. C., and such points in the field as may be necessary.

*Date begun.*—1918.

*Assignment.*—Advisory committee: W. A. Taylor, C. L. Alsberg, and Charles J. Brand; leaders, Herbert C. Marshall, George Livingston, and J. H. Shollenberger, of the Bureau of Markets; and a representative of the Bureau of Chemistry.

*Proposed expenditure, 1918-19.*—\$50,000.

**ENFORCEMENT OF THE UNITED STATES COTTON-FUTURES ACT.****Administration:**

*Object.*—To supervise and direct the regulatory service and investigational activities of the Bureau of Markets in connection with the enforcement of the United States cotton-futures act and the rules and regulations of the Secretary of Agriculture thereunder, and to perform such executive and clerical duties as may be necessary in connection therewith.

*Cooperation.*—Office of the Solicitor, in matters involving points of a legal nature and questions of general policy, and the Treasury Department, in matters pertaining to the work imposed by the act upon that department.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—Publications: Office of the Secretary Circulars 46 and 64, "Rules and Regulations of the Secretary of Agriculture under the United States Cotton-Futures Act," and Service and Regulatory Announcements of the Office of Markets and Rural Organization relating to the enforcement of the cotton-futures act.

*Assignment.*—Charles J. Brand, D. S. Murph, Fred Taylor, and G. R. Argo, board of examiners; Fred Taylor, D. E. Earle, J. G. Martin, R. L. Francis, George Butterworth, O. J. McConnell, and Harold C. Slade; committee on final inspection: Fred Taylor, D. E. Earle, George Butterworth, Harold C. Slade, and F. W. Knight.

*Proposed expenditures, 1918-19.*—\$17,490 (regulation, \$4,000; service, \$9,000; research, \$4,490).



## [Regulation.]

**Determination of Disputes:**

*Object.*—To hear and determine disputes as to the grade, quality, or length of staple of cotton tendered in settlement of future contracts made in compliance with section 5 of the cotton-futures act and referred to the Secretary of Agriculture under the terms of the act for determination of facts; and to draw up memoranda of conclusions upon which are based the Secretary's findings in cases of disputes.

*Procedure.*—Under the United States cotton-futures act disputes as to the grade, quality, or length of staple of cotton tendered in settlement of future contracts may be referred by either party to the Secretary of Agriculture for his determination by submitting a sample of each bale in dispute and filing the necessary papers relating thereto in accordance with regulation 2 of the rules and regulations of the Secretary of Agriculture. When these samples are received by the department they are opened and placed in a conditioning room until called for by the clerk to the examiners. They are then arranged in convenient order for the examiners, who have been designated by the Secretary of Agriculture to pass judgment upon and render a memorandum of their conclusions as to the facts in dispute. The findings of the Secretary of Agriculture are sent to the parties in dispute and have the effect of prima facie evidence in all United States courts. A memorandum of the charges assessed against each party is prepared and forwarded to them in accordance with the provisions of section 31, paragraph 2, rules and regulations of the Secretary of Agriculture.

*Cooperation.*—Office of the Solicitor, in matters involving points of a legal nature, including the preparation of findings for the signature of the Secretary.

*Location.*—Washington, D. C. Temporary headquarters may be established at various points in the United States should occasion require, as provided in the rules and regulations of the Secretary of Agriculture under the United States cotton-futures act.

*Date begun.*—Preliminary work commenced shortly after August 18, 1914. The first dispute was referred to the Secretary on March 15, 1915.

*Results.*—To June 30, 1918, 1,411 disputes, involving 84,300 bales of cotton, were referred to the Secretary, upon which findings were issued.

*Assignment.*—George R. Argo, R. L. Francis, George Butterworth, A. M. Agelasto.

*Proposed expenditures, 1918-19.*—\$16,750.

## [Research.]

**Investigations of Future and Spot Markets for Cotton:**

*Object.*—To investigate future markets for cotton to ascertain how accurately their future quotations reflect spot values, and to secure general information as to conditions within the future exchanges; to investigate spot markets to determine their fitness for designation as bona fide spot markets; to secure daily reliable quotations for cotton from each of the designated spot markets; and to inspect the designated bona fide spot markets from time to time.

*Procedure.*—Investigations are made of transactions in future markets to ascertain whether the provisions of the act are being carried out, and of various spot markets to determine whether they are qualified for designation as bona fide spot markets, i. e., whether the exchanges in these markets will meet certain conditions necessary for their designation as bona fide spot markets. Quotations received from these bona fide spot markets are checked to determine whether they are correct and whether they continue to meet the requirements of a bona fide spot market.

*Cooperation.*—Cotton exchanges in the designated spot markets, the future exchanges at New York and New Orleans, and various cotton associations and firms throughout the United States.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—At present the following cities are designated as bona fide spot markets for cotton under the cotton-futures act: Augusta, Ga., Dallas,



Tex., Houston, Tex., Little Rock, Ark., Memphis, Tenn., Montgomery, Ala., Norfolk, Va., Savannah, Ga., New Orleans, La., Charleston, S. C., Mobile, Ala., Galveston, Tex., Fort Worth, Tex., and Atlanta, Ga. Quotations are received at the Washington office of the bureau and by the future exchanges at New York and New Orleans from the first 10 of the cities named. The average of these quotations constitutes commercial differences for use in the settlement of future contracts made on the New York Cotton Exchange.

*Assignment*—George R. Argo, M. F. Stiles, Reynolds Kohlheim.

*Proposed expenditures, 1918-19.*—\$14,770.

[Service.]

### Preparation and Distribution of the Official Cotton Standards of the United States:

*Object.*—To prepare and distribute practical forms of the official cotton standards of the United States for grades of white cotton, promulgated by the Secretary of Agriculture on December 15, 1914, under section 9 of the United States cotton-futures act, and practical forms of the official standards for colored cotton, promulgated by the Secretary of Agriculture on January 28, 1916, under the same section of the act; to inspect these copies of the standards, condemn them when necessary, and replace them upon request; and to prepare and distribute standards for any quantity or condition of cotton which may be officially promulgated. (Field and laboratory investigations and demonstrations of standards are carried on under another project.)

*Procedure.*—Bales of cotton of various grades representing the characteristic qualities of the cotton of each State are purchased throughout the cotton belt and used for the preparation of copies of the official standards. Copies of the standards certified under the seal of the Department of Agriculture are placed in boxes specially constructed for the purpose. In the lid of each box is placed a photograph of its contents at the time of certification.

The standards for white cotton are prepared in sets of 9 boxes, each box representing a grade and containing 12 samples or types showing the degree of variation permissible within the grade. The white standards are sold for \$20 a set. The standards for colored cotton are prepared in sets of 11 boxes, each box representing a grade and containing 12 samples showing the degree of variation permissible within the grade. The standards for colored cotton are sold at \$25 a set. Fractional or broken sets of standards are supplied upon request. Purchasers of official standards hold them subject to inspection by representatives of the Department of Agriculture, and if for any reason they are found upon inspection to have deteriorated since their preparation, or to misrepresent the official cotton standards in any way, the certificate of grade may be canceled or removed. Examination of any set or box of standards delivered at Washington by the purchasers will be made free of charge, any sample or type which may be found not accurately to represent the official cotton standards being replaced, if desired, at a nominal charge. The photograph of the standards is renewed without cost.

*Location.*—Washington, D. C.

*Date begun.*—1914.

*Results.*—(1) During 1918: There were prepared and distributed in the United States 70 full and 28 fractional sets of the white standards promulgated on December 15, 1914, and repromulgated on August 12, 1916; also 19 sets of the colored standards. In addition to these, 3 full sets of the white standards were sent to foreign countries.

(2) Prior to 1918: The following standards for grades of white cotton were established and promulgated on December 15, 1914: Middling fair, strict good middling, good middling, strict middling, middling, strict low middling, low middling, strict good ordinary, and good ordinary.

The following standards were established and were promulgated on January 28, 1916: Yellow-tinged cotton of the grades of good middling, strict middling, middling, strict low middling, and low middling; yellow-stained cotton of the grades of good middling, strict middling, and middling; and blue-stained cotton of the grades of good middling, strict middling, and middling. Prior to the fiscal year 1918, 829 sets of the white standards and 67 sets of the colored standards were distributed



throughout the United States and 23 sets of white standards and 9 sets of colored standards sent to foreign countries, including Canada, England, India, China, Japan, Holland, Germany, France, and Russia.

*Assignment.*—Fred Taylor, D. E. Earle, R. L. Kauser, F. W. Knight, George P. Taylor, J. B. Beers, G. T. Brooks, N. T. Bringham, H. E. Tucker, N. H. Willbanks.

*Proposed expenditures, 1918-19.*—\$71,110.

**Total, Enforcement of the United States Cotton-Futures Act, \$120,110, including \$6,540 statutory (regulation, \$20,750; service, \$80,110; research, \$19,260).**

[Regulation.]

## ENFORCEMENT OF THE UNITED STATES GRAIN-STANDARDS ACT.

### Administration:

*Object.*—To supervise and direct the investigational and regulatory activities involved in the enforcement of the United States grain-standards act and the rules and regulations of the Secretary of Agriculture thereunder.

*Cooperation.*—Office of the Solicitor, in matters involving points of a legal nature and questions of general policy, and other offices and bureaus of the department; State authorities and commercial and producing grain interests. Certain phases of the work relating to the enforcement of the United States warehouse act are carried on in cooperation with work conducted under this appropriation.

*Location.*—Headquarters, Washington, D. C. Permanent branch offices have been established at the following grain markets; Atlanta, Baltimore, Boston, Buffalo, Cairo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Duluth, Fort Worth, Galveston, Indianapolis, Kansas City (Mo.), Louisville, Memphis, Milwaukee, Nashville, Minneapolis, New Orleans, New York City, Oklahoma City, Omaha, Peoria, Philadelphia, Pittsburgh, Portland (Oreg.), San Francisco, Salt Lake City, Seattle, Spokane, Toledo, St. Louis, and Wichita.

*Date begun.*—1916.

*Results.*—Standards for shelled corn and wheat have been established under the provisions of the act and the application of such standards enforced on corn since December 1, 1916, on winter wheat since July 1, 1917, and on spring wheat since August 1, 1917. Investigational work with reference to standards for oats has reached an advanced stage and is in progress for other grains.

Publications: Service and Regulatory Announcements 11, 12, 13, 14, 15, 17, 18, 19, 22, 23, 24, 25, 26, 29, 31, 32, and 33 and Circular 70 of the Office of the Secretary.

*Assignment.*—Charles J. Brand and George Livingston; specialists and grain supervisors: J. W. T. Duval, Harold J. Besley, Emil G. Boerner, Ralph H. Brown, Joshua M. Chilton, Clifford G. Franks, William J. O'Loughlin, Joseph H. Shollenberger, Fred G. Smith, Harold Anderson, Chas. B. Barron, Parker J. Bollman, Calhoun L. Cannon, William P. Carroll, John T. Cavanagh, John H. Cox, John H. Edwards, Laurel Duval, Henry B. Evans, Walter Fowler, Lee Gallaher, Herbert H. Gear, Charles F. Hegwein, Edward J. Hickey, Ephraim A. Hill, Robert D. Jarboe, Ed. Keiser, John C. Kerr, James A. LeRoy, E. Harley Linzee, William H. McDonald, James F. MacKenzie, Hugh A. Martin, Rutherford T. Miles, Robert C. Mill, Ralph C. Miller, Evan L. Morris, Cecil E. Munn, Virgil L. Nigh, Edward C. Noll, Asa B. Parker, Oscar F. Phillips, Harry A. Rhoades, Philip Rothrock, Clark A. Russell, Robert R. Saunders, William F. Shanahan, John Sheedy, Oscar L. Spencer, Byron J. Stubblefield, Fred L. Wallace, Bert W. Whitlock, Ralph B. Woolsey, Clarence B. Wright, Ralph C. Wright.

*Proposed expenditures, 1918-19.*—\$447,500.

### Appeals and Inspection Procedure:

*Object.*—To hear and determine appeals and disputes from the grading of grain which may be referred to the Secretary of Agriculture under the United States grain-standards act, in accordance with the rules and regulations promulgated thereunder, and to prepare the findings in each case; to review analyses and separations of samples submitted in con-



nection with appeals and disputes and in connection with the supervision work performed under the act; to prepare and distribute type samples of grain illustrating the application of the official grain standards; to standardize laboratory methods and procedure employed in the handling of appeals and disputes; to prepare outlines of procedure and instructions relating to the sampling, testing, and analyzing of grain under the act; to standardize, adjust, and calibrate grain-testing apparatus in use in the offices of Federal grain supervision of the Bureau of Markets, grain-inspection departments, and grain-testing laboratories; and to develop improved laboratory methods and devise improved grain-testing apparatus and equipment.

*Procedure.*—Appeals from the inspection and grading of grain by licensed inspectors and disputes respecting uninspected grain are filed by parties to the transaction with the office of Federal grain supervision in the district in which the inspection is performed or the grain is located. The supervisor in charge of such office determines whether it has jurisdiction to entertain the appeals or disputes, causes official samples of such grain to be taken and analysis determinations to be made, and issues to the respective parties to the transactions memoranda of the true grade of the grain. The records of such appeals or disputes are forwarded to the Washington office, together with advance deposits. Advance deposits are transmitted by the Washington office to the disbursing clerk of the department, the records of the appeals and disputes are carefully checked, and review is made of the analysis separations of the samples of grain involved. Formal findings of the Secretary of Agriculture are then prepared and copies sent to the parties, together with any refund that may be due. Refunds of the entire deposit are made in cases where the appeals are sustained. The costs not refunded are covered into the Treasury of the United States. The analyses separations in samples of grain involved in appeals and disputes and in supervision work are forwarded to the Washington office, reviewed by the board of final review, and form the basis of the findings of the Secretary of Agriculture. Type samples illustrating the application of the official grain standards are prepared and distributed among grain supervisors to insure uniformity in the handling of the appeals and disputes and in supervision work. Standardized methods are developed in the entire procedure of laboratory work in connection with grain grading and grain supervision. Assistance is rendered to the grain trade, to grain inspectors, and to the grain-inspection departments of State boards of trade, grain exchanges, and other organizations with regard to the proper methods and procedure to be employed in sampling, testing, and analyzing grain. Laboratory equipment in the offices of Federal grain supervision and at the Washington office is installed in order to insure absolute uniformity. New and improved laboratory equipment is developed.

*Cooperation.*—Same as "Administration."

*Location.*—Same as "Administration."

*Date begun.*—1916.

*Results.*—(1) To June 30, 1918, 1,744 appeals and 14 disputes have been heard. The amounts collected for costs have been covered into the Treasury or refunded to the parties concerned, as the case required.

Much assistance has been rendered to members of the grain trade and to grain inspectors with regard to the proper methods and procedure to be followed in sampling, testing, and analyzing grain. Laboratory procedure has been standardized and detailed instructions regarding the handling of appeal and dispute samples and samples of grain secured in the supervision work prepared and distributed. Uniform laboratory equipment has been procured and installed in the offices of Federal grain supervision and in Washington. Working conditions in the various laboratories have been made uniform. Tables of equivalents for use in making analyses have been prepared and distributed. New and improved laboratory equipment has been developed, including apparatus for determining the test weight per bushel on different grains, grain probes used in sampling work, remodeled dockage machines, newly designed laboratory tables for analytical and review work, and a grain-sampling device for obtaining a representative portion of a sample of grain for testing and analysis. Type samples of wheat and corn showing classes



and subclasses, damaged kernels, heat-damaged kernels, etc., have been prepared. All analysis separations of grain samples made in the field offices have been reviewed at the Washington office by the board of final review. Uniformity in the laboratory work in the field has increased the efficiency of the work of the licensed inspectors, who are constantly under the supervision of grain supervisors in the district in which such inspectors are located.

*Assignment.*—George Livingston and E. G. Boerner; board of final review: E. G. Boerner, W. J. O'Loughlin, J. H. Shollenberger, C. G. Franks, H. J. Besley, J. M. Chilton

*Proposed expenditures, 1918-19.*—\$24,720.

### **Inspection Efficiency:**

*Object.*—To supervise the inspection of grain in order to secure the correct and uniform application of the official grain standards of the United States; to cause examinations to be made of any grain which has been shipped or delivered for shipment in interstate or foreign commerce when sold, offered, or consigned for sale by grade or which has been graded by a licensed inspector, for the purpose of determining whether it conforms to the standard of the grade specified; to supervise the keeping of all records of grain graded and inspected by licensees under the grain-standards act, the collection of reports, and the compilation for publication of the summary of facts required by section 7 of the act.

*Procedure.*—A system of efficiency reports of licensed inspectors, based upon records of grain supervisors under whose immediate jurisdiction the licensed inspectors perform inspection services, has been installed for the purpose of ascertaining the degree of accuracy with which the Federal standards for grain are applied by individual inspectors and at the several markets. The 35 districts of Federal grain supervision, into which the United States is divided, have been grouped into six divisions. The grouping has in view placing in one division such districts as have grain problems in common and the assignment to each division of a division supervisor whose duty it is to study such problems and recommend immediate action for their solution. Adequate forms of record for reporting to the Secretary of Agriculture the place and date of inspection, name of elevator or warehouse, and the kind, quantity, and grade of grain have been prepared. Summaries of the information obtained from these records are prepared for publication on the first Tuesday in January and July of each year, as provided in the act. Information obtained from such records is correlated with other records covering the inspection and grading of grain, in order that the department may have readily available valuable information regarding the quality and condition of grain marketed throughout the year, especially with respect to the moisture content, weight per bushel, purity, and such other factors as are indicative of quality and condition.

*Cooperation.*—Same as "Administration."

*Location.*—Same as "Administration."

*Date begun.*—1916.

*Results.*—Efficiency in the inspection and grading of grain for which standards have been fixed and established by the Secretary of Agriculture has been greatly increased as a result of this work. A greater degree of uniformity in the application of the standards in the various markets has resulted. This has been made possible by (1) the enforced use of a uniform set of standards throughout the country; (2) interpretation of these standards by a single authority, the Department of Agriculture, through a board of review, located in Washington; (3) maintenance of close contact between the department's board of review and grain supervisors of the department located at the principal grain markets throughout the United States; and (4) active supervision by grain supervisors over the work of licensed inspectors.

*Assignment.*—George Livingston, H. J. Besley, J. M. Chilton.

*Proposed expenditures, 1918-19.*—\$36,000.

### **Licenses and Violations:**

*Object.*—To investigate supposed or alleged violations of the grain-standards act and of the rules and regulations thereunder, to hold hearings with respect to the same, if necessary, and to make recommendations regarding the action to be taken in each case; to carry into effect the



provisions of section 7 of the act with respect to the issuance, suspension, revocation, or cancellation of licenses; to pass upon the forms of grain-inspection certificates used by licensed inspectors; and to assist in the preparation of rules and regulations under the act.

*Procedure.*—Applicants for licenses to inspect and grade grain are examined by methods which have been fixed upon, in cooperation with the Civil Service Commission, and qualified persons are licensed to inspect and grade grain for shipment or delivery for shipment in interstate or foreign commerce and to certificate the grade thereof. Hearings are held upon charges of incompetency, and licenses of inspectors are suspended or revoked, when necessary, for knowingly or carelessly grading grain improperly or by other than the United States standards, for the issuance of false certificates, for the acceptance of money or other considerations, for the neglect or improper performance of duty, or for violations of the act or the rules and regulations made thereunder. Evidence is collected and hearings held in connection with apparent violations of the act or the rules and regulations thereunder by persons other than licensed inspectors.

*Cooperation.*—Same as "Administration."

*Location.*—Same as "Administration."

*Date begun.*—1916.

*Results.*—To June 30, 1918, licenses had been issued to 428 inspectors; 336 licenses were issued to inspect and grade shelled corn only, 4 licenses to inspect and grade wheat only, 353 licenses covering both shelled corn and wheat, a total of 693 licenses. Fifty persons were refused licenses, of whom 45 failed in their applications to show the necessary qualifications and 5 were found deficient on examination. Forty-two licenses have been suspended and 59 canceled at the request of the licensees, in cases where the inspectors have become engaged either temporarily or permanently in other lines of work. The licenses of 2 inspectors have been suspended pending investigation and the licenses of 3 inspectors revoked on account of inefficiency or violations of the act.

All forms used in the inspection of shelled corn and wheat by licensed inspectors throughout the United States have been passed upon and approved, insuring uniformity in the certificates and compliance with the provisions of the act.

Investigations have been made of complaints filed by grain concerns and of violations which have come to the attention of officials in connection with the supervision work. A large number of cases have been investigated which involve shipment of grain in interstate commerce by grade and without inspection, the inspection and grading of interstate shipments of grain by unlicensed persons, the representation or invoicing of grain contrary to the grades placed thereon by licensed inspectors, the misgrading of grain by licensed inspectors, the use of grades other than the official grain standards of the United States in connection with interstate shipments, employment of licensed inspectors by commercial grain concerns or financial interest of inspectors in such concerns, and other violations of the grain-standards act. Investigations also are being conducted of grain-inspection and grain-grading practices in different sections which involve possible violations of the act, and of the sale and handling of grain by type and by sample and by private grading systems adopted by individual persons and concerns. Where deemed expedient, hearings have been afforded the parties charged with such violations. Cases have been prepared for prosecution where the facts warranted or the facts prepared for publication as provided in section 5 of the act.

*Assignment.*—George Livingston, A. W. Herger, Fred G. Smith, Henry B. Evans, E. J. Murphy.

*Proposed expenditures, 1918-19.*—\$18,600.

**Total, Enforcement of the United States Grain-Standards Act, \$526,820.**  
including \$70,240 statutory.

[Regulation.]

## ADMINISTRATION OF THE UNITED STATES WAREHOUSE ACT.

### Administration of the United States Warehouse Act:

*Object.*—To inspect and classify warehouses applying for licenses under the United States warehouse act; to license warehouses that are found to



be suitable for the proper storage of cotton, grains, flaxseed, wool, and tobacco; to license qualified persons to classify any agricultural product or products stored or to be stored in a warehouse licensed under this act, according to grade or otherwise, and to certificate the grade or class thereof, or to weigh the same and certificate the weight thereof, or both to classify and weigh the same and to certificate the grade or other class and the weight thereof; to license any person not a warehouseman to accept custody of cotton, grains, flaxseed, wool, and tobacco, and to store same in a warehouse owned or operated by any State; to prescribe the duties of warehousemen licensed by the Secretary of Agriculture, to make rules and regulations for carrying out the provisions of the United States warehouse act, and to prescribe the conditions of the bond required of licensed warehousemen; to investigate the storage, warehousing, classifying according to grade or otherwise, weighing, and certification of cotton, grains, flaxseed, wool, and tobacco; and to make such other investigations as may be necessary for carrying out the provisions of the United States warehouse act; and from time to time to establish and promulgate standards for such of the agricultural products defined in this act as are not already standardized.

*Procedure.*—Studies are made of the practices of warehousemen in order to make rules and regulations for carrying out the provisions of the warehouse act. Forms for applications and inspections are drafted, and when warehousemen or weighers and classifiers apply for licenses under the act such inspections and examinations as may seem necessary are made to determine whether the warehouses are suitable for the proper storage of agricultural products and to determine whether the applicants for licenses as weighers and classifiers are capable of performing these duties. Such inspections as may seem necessary are made in order to classify warehouses in accordance with the provisions of the act. Where no legal standards have been provided for agricultural products to be stored in licensed warehouses, or where such standards are in process of formulation by the bureau, a study of the commercial standards and grades or other methods of classification now in use will be made, and, if necessary, standards will be formulated.

*Cooperation.*—Office of the Solicitor, State experiment stations, colleges of agriculture, private individuals, commercial companies, insurance and bonding companies, fire-insurance underwriters' associations, and State officials in charge of State warehousing and marketing departments.

*Location.*—Washington, D. C., all sections where the agricultural products defined in the act are grown and stored, and places outside of the producing sections where such products are concentrated and held in storage.

*Date begun.*—1916.

*Results.*—General investigations in connection with the enforcement of the United States warehouse act have been continued, and much information has been collected in addition to that heretofore obtained as to the location, capacity, cost, conditions, better methods, etc., in warehouses and warehousing throughout the country. Regulations under the act have been completed for cotton warehouses, application forms are now available for distribution, and the necessary equipment is being installed for handling applications, issuing licenses, and other business relating to the administration of the act. The investigations in reference to grain warehouses—particularly the study of insurance, the protection of grain, and other matters bearing directly on the administration of the act—have progressed satisfactorily. Tentative regulations have been drafted and are being submitted to competent authorities for suggestions prior to their promulgation. Lists have been established of tobacco warehouses and wool warehouses. Investigational work with reference to the storage of wool is just being undertaken. Special efforts are being made to collect data, which will be published later, bearing on the improvement of storage conditions generally and especially on the construction of warehouses. Effort will be made to standardize structural requirements for warehouses for the storage of agricultural products. Progress is being made in the classification of products embraced under the warehouse act.

*Assignment.*—D. S. Murph, R. L. Nixon, Roy L. Newton, J. P. Brown, R. B. Smith, T. L. Hughes, S. G. Hilton, F. E. Fitzpatrick.

*Proposed expenditures, 1918-19.*—\$54,940, including \$1,400 statutory.



## INSECTICIDE AND FUNGICIDE BOARD.

### ENFORCEMENT OF THE INSECTICIDE ACT.

#### Administration:

*Object.*—To act for the board in all matters pertaining to the enforcement of the insecticide act and incidental business affairs.

*Procedure.*—Samples of insecticides and fungicides are collected by inspectors operating throughout the United States, and samples from consignments offered for import at the various ports of entry are taken; distribution is made of such samples for analysis and test, and reports thereon are assembled and all necessary action taken to carry out the recommendations of the board in respect to the disposition of cases and administrative matters, including the arranging for hearings, collecting evidence, correspondence, preparing cases for reference to the Solicitor, maintaining records and files, attending to fiscal matters, purchasing and accounting for property, and all other business details.

*Cooperation.*—Bureaus of Animal Industry, Plant Industry, Chemistry, and Entomology, and Office of the Solicitor; and Treasury, Commerce, and State Departments.

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—General compliance with the law is being obtained, resulting in great improvement in labeling and better and more standardized grades of the products appearing on the market. During the fiscal year 1918 approximately 644 samples were collected; 106 cases were reported for prosecution, 176 cases taken up by correspondence, and 805 cases placed in permanent abeyance.

*Assignment.*—J. K. Haywood, chairman of board; J. G. Shibley, executive officer.

*Proposed expenditures, 1918-19.*—\$44,041, including reserve of \$11,000 for the trial of cases (regulation, \$43,441; research, \$600).

#### [Regulation.]

#### **Routine Chemical, Microscopic, and Bacteriological Examination of Insecticides and Fungicides (Including Disinfectants) Other than Those Used on Horses, Cattle, Sheep, Swine, or Goats:**

*Object.*—To control the traffic in domestic and foreign insecticides and fungicides of the type mentioned.

*Procedure.*—Samples of these insecticides and fungicides are collected in the open market and examined to determine whether or not they are adulterated or misbranded under the provisions of the insecticide act.

*Cooperation.*—Same as project "Administration."

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—Same as project "Administration." During 1918 approximately 950 samples were examined. A special campaign was made against misbranded and adulterated disinfectants, with the result that a great improvement has been brought about in this direction.

*Assignment.*—J. K. Haywood, chairman of board.

*Proposed expenditures, 1918-19.*—\$39,746.

#### **Routine Testing of Efficacy of Fungicides and Action on Foliage of Insecticides and Fungicides:**

*Object.*—To control interstate traffic in domestic and foreign fungicides and insecticides.



*Procedure.*—Samples of fungicides and insecticides collected in the open market are tested to determine whether they are adulterated or misbranded under the provisions of the insecticide act.

*Cooperation.*—Same as project "Administration."

*Location.*—Washington, D. C., Arlington Farm, Va., and leased orchards and truck patches.

*Date begun.*—1910.

*Results.*—Same as project "Administration." During 1918 approximately 225 samples were examined. A special campaign was conducted to determine the value of various preparations used for purposes of tree medication in the treatment of fungous diseases, as well as so-called remedies for pear blight.

*Assignment.*—M. B. Waite, member of board.

*Proposed expenditures, 1918-19.*—\$10,562.

### **Routine Testing of Efficacy of Insecticides and Their Action on Foliage:**

*Object.*—To control interstate traffic in domestic and foreign insecticides.

*Procedure.*—Samples of insecticides collected in the open market are tested to determine whether or not they are adulterated or misbranded under the provisions of the act.

*Cooperation.*—Same as project "Administration."

*Location.*—Washington, D. C., and Vienna, Va.

*Date begun.*—1910.

*Results.*—Same as project "Administration." During 1918 approximately 570 samples were examined. A special campaign was made to determine the efficacy of so-called tree vaccination preparations, tree-trunk washes, soil insecticides, and insecticides claimed to control the cotton boll weevil.

*Assignment.*—A. L. Quaintance, member of board.

*Proposed expenditures, 1918-19.*—\$11,778.

### **Routine Chemical and Bacteriological Examination of Insecticides and Fungicides Used Primarily on Horses, Cattle, Sheep, Swine, or Goats, and Efficacy Tests of Same.**

*Object.*—To control traffic in the domestic and foreign insecticides and fungicides of the type mentioned.

*Procedure.*—Samples of these insecticides and fungicides are collected in the open market and examined to determine whether or not they are adulterated or misbranded under the provisions of the insecticide act.

*Cooperation.*—Same as project "Administration."

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—Same as project "Administration." During 1918 approximately 92 samples were examined. A special campaign was conducted to ascertain the efficacy of preparations proposed for use in the eradication of cattle ticks and of dips on the market used in combating sheep and cattle scab.

*Assignment.*—James A. Emery, member of board.

*Proposed expenditures, 1918-19.*—\$8,213.

#### **[Research.]**

### **Chemical, Microscopic, and Bacteriological Investigations of Insecticides and Fungicides (Including Disinfectants) Other than Those Used on Horses, Cattle, Sheep, Swine, or Goats:**

*Object.*—To obtain basic information relative to these insecticides and fungicides and of materials used in their preparation, which is necessary in the enforcement of the insecticide act, improve methods of examining insecticides and fungicides, establish standards for insecticides and fungicides, and aid manufacturers in methods of preparation.

*Procedure.*—As new questions arise relative to methods of analysis, standards for insecticides and fungicides, the chemistry of new insecticides and fungicides, and methods of manufacturing insecticides and fungicides, they are made the subject of investigative study.

*Cooperation.*—Bureau of Chemistry.

*Location.*—Washington, D. C.

*Date begun.*—1910.



*Results.*—(1) Prior to 1918: New methods of examining many insecticidal and fungicidal materials evolved; standards for certain insecticides and fungicides tentatively adopted on basis of this work; and the chemical properties of insecticides and fungicides investigated and suggestions furnished to manufacturers relative to methods of preparing insecticides and fungicides. The following papers have been published: "The Electrolytic Separation of Zinc, Copper, and Iron from Arsenic"; "The Reduction of  $As^5$  to  $As^3$  by Cuprous Chloride and the Determination of Arsenic by Distillation as Arsenic Trichloride"; "The Preparation and Properties of Lead Chloroarsenate"; and three papers on "The Arsenates of Lead."

(2) During 1918 the above-mentioned work was continued and the following papers published: "The Action of Water on Dilead Arsenate" and "The Occurrence of Manganese in *Chrysanthemum Cinerariaefolium*." Papers have been prepared and are ready for publication on the following subjects: "Plants Used as Insecticides"; "I. Insect Powder: Adulteration of and Methods of Detection. II. Active Principle of Insect Powder"; and "Toxin Formation by a variety of *B. Botulinus*."

*Assignment.*—J. K. Haywood, chairman of board; C. C. McDonnell.

*Proposed expenditures, 1918-19.*—\$4,000.

### **Investigations of the Efficacy of Fungicides and Action of Fungicides and Insecticides on Vegetation:**

*Object.*—To obtain basic information necessary in the enforcement of the insecticide act relative to the action of fungicidal materials on fungi, improve methods of testing fungicides, and secure data relative to the action of fungicides and insecticides and insecticidal and fungicidal materials on vegetation.

*Procedure.*—As new questions arise relative to the activity or nonactivity of fungicides and fungicidal materials and the action of fungicides, insecticides, and insecticidal and fungicidal materials on vegetation, these are made the subject of investigative study.

*Cooperation.*—Bureaus of Plant Industry, Entomology, and Chemistry.

*Location.*—Washington, D. C., Arlington Farm, Va., and leased orchards and truck patches.

*Date begun.*—1910.

*Results.*—(1) Prior to 1918: The activity or nonactivity against fungi of a number of substances determined; action of a number of groups of insecticides and fungicides on vegetation also determined and general conclusions drawn relative thereto; results used in correspondence and in the enforcement of the insecticide act. An investigation was made of the problem of controlling diseases by tree medication or the direct feeding of chemicals to trees or plants, either by injection into the tissue or through the roots.

(2) During 1918: The problem of dusting orchards and field crops with finely ground sulphur and other powdered fungicides has been continued. Considerable data relative to the efficacy of some of these preparations against certain plant diseases have been accumulated. A special investigation of the efficacy of various types of fungicides against late blight of potatoes was undertaken.

*Assignment.*—M. B. Waite, member of board; Errett Wallace.

*Proposed expenditures, 1918-19.*—\$800.

### **Investigations of the Efficacy of Insecticides and Action of Same on Vegetation:**

*Object.*—To obtain information relative to the action of insecticides and insecticidal materials on insects, as necessary in the enforcement of the insecticide act; to improve methods of testing insecticides; and to secure data relative to the action of insecticides and insecticidal materials on vegetation.

*Procedure.*—As new questions arise relative to the activity or nonactivity of insecticides and insecticidal materials and the action of same on vegetation, these are made the subject of investigative study.

*Cooperation.*—Bureaus of Entomology, Plant Industry, and Chemistry.

*Location.*—Washington, D. C., and Vienna, Va.

*Date begun.*—1910.



*Results.*—(1) Prior to 1918: The activity or nonactivity of 231 substances against various insects, as well as their action on vegetation, was determined and general conclusions drawn relative thereto; results used in the enforcement of the insecticide act and in correspondence. A number of substances, including virulent poisons, were tested with regard to their action against insects by introducing the insecticides into the tissues of the plant. The value of dust sprays in the field was investigated.

(2) During 1918: The work above outlined was continued. Papers on "Results of Experiments with Miscellaneous Substances against Bedbugs, Cockroaches, Clothes Moths, and Carpet Beetles" and "A Study of the Effect of Storage, Heat, and Moisture on Pyrethrum" were completed and submitted for publication.

*Assignment.*—A. L. Quaintance, member of board; E. W. Scott.

*Proposed expenditures, 1918-19.*—\$1,500.

**Chemical, Bacteriological, and Toxicological Investigations of Insecticides and Fungicides Used Primarily on Horses, Cattle, Sheep, Swine, or Goats, and Efficacy Tests of Same:**

*Object.*—To obtain basic information relative to these insecticides and fungicides and of materials used in their preparation, which is necessary in the enforcement of the insecticide act; to improve methods of examining and testing such insecticides and fungicides; to secure data relative to the activity or nonactivity of substances used in such insecticides and fungicides; and to investigate the toxic action of such insecticides, fungicides, and materials which are used in their preparation.

*Procedure.*—As new questions arise relative to methods of analysis, the activity or nonactivity of certain substances used in insecticides and fungicides, the efficacy of certain insecticides and fungicides, and the toxic action of certain insecticides and fungicides and materials used in same, these are made the subject of investigative study.

*Cooperation.*—Bureau of Animal Industry.

*Location.*—Washington, D. C.

*Date begun.*—1910.

*Results.*—(1) Prior to 1918: New methods of examining certain insecticides and fungicides have been evolved; the activity or nonactivity against insects and fungi of many substances determined; and the toxic properties of a number of substances ascertained; results used in the enforcement of the insecticide act and in correspondence.

(2) During 1918: The work above outlined was continued.

*Assignment.*—James A. Emery, member of board; H. H. Custis.

*Proposed expenditures, 1918-19.*—\$600.

**Total, Enforcement of the Insecticide Act, \$121,240, including \$26,750 statutory (regulation, \$113,740; research, \$7,500).**



## FEDERAL HORTICULTURAL BOARD.

### ENFORCEMENT OF THE PLANT-QUARANTINE ACT.

#### ADMINISTRATION.

##### Administration:

*Object.*—Supervision of the board's activities and the performance of such duties as are common to the board as a whole, the cost of which can not be readily prorated against the various projects involved, such as accounting and editorial work, purchasing, distributing, and accounting for property and supplies, arranging for and conducting hearings, collecting evidence, preparing cases for reference to the Solicitor, correspondence, maintaining records and files, and all other business details necessary for carrying out the recommendations of the board.

*Cooperation.*—Bureaus of Entomology, Plant Industry, Markets, and Chemistry, and Forest Service; Office of the Solicitor and Office of Information; and Treasury, State, and Post Office Departments.

*Location.*—Washington, D. C.

*Date begun.*—1912.

*Results.*—General compliance with the law and with the quarantine and other restrictive orders issued thereunder is being obtained.

*Assignment.*—C. L. Marlatt, chairman; R. C. Althouse, secretary.

*Proposed expenditures, 1918-19.*—\$12,460, statutory (regulation, \$12,000; research, \$460).

#### [Regulation.]

### CONTROL OF ENTRY OF PLANTS AND PLANT PRODUCTS UNDER REGULATION.

##### Nursery Stock:

*Object.*—To guard against the introduction of injurious plant diseases and insect pests.

*Procedure.*—Issuance of permits; providing for foreign inspection and certification of nursery stock and for reinspection of such stock either at port of entry or at place of destination; securing proper reports from importers and customs officials of arrival and proposed distribution, and transmitting such reports to State inspectors; keeping records of importations, and taking steps to maintain full compliance with the regulations on the part of inspectors in export countries as to proper certification and marking, and on the part of importers as to notification, examination, or disinfection at port of entry or at destination.

*Cooperation.*—State inspectors, customs officials, American consuls and postmasters, and inspectors in foreign countries.

*Location.*—Washington, D. C., and ports of entry concerned.

*Date begun.*—1912.

*Results.*—General compliance with regulations being secured; marked improvement in condition of nursery stock as to freedom from pests.

*Assignment.*—C. L. Marlatt, Lester E. Palmer, E. R. Sasscer, R. Kent Beattie.

*Proposed expenditures, 1918-19.*—\$16,000.

##### Potatoes:

*Object.*—To guard against the introduction of injurious potato diseases and insect pests.

*Procedure.*—Issuance of permits; providing for foreign inspection and certification and for reinspection at port of entry; securing proper reports of arrival from importers and customs officials; keeping records of importations; and taking steps to maintain full compliance with the regulations on the part of inspectors in export countries as to proper cer-



tification and marking, and on the part of importers as to notification and inspection at port of entry.

*Cooperation.*—State inspectors, customs officials, American consuls, and inspectors in foreign countries.

*Location.*—Washington, D. C., and ports of entry concerned.

*Date begun.*—1913.

*Results.*—General compliance with regulations being secured; marked improvement in condition as to freedom from disease of potatoes offered for entry.

*Assignment.*—C. L. Marlatt, Lester E. Palmer, R. Kent Beattie, H. B. Shaw.

*Proposed expenditures, 1918-19.*—\$2,000.

#### **Avocados:**

*Object.*—To guard against the introduction of the avocado weevil.

*Procedure.*—Issuance of permits securing proper reports of arrival from the importers and customs officials; providing for inspection of avocados at port of entry; keeping records of importations; and taking steps to maintain full compliance with the regulations on the part of importers as to notification and inspection at port of entry.

*Cooperation.*—Customs officials and American consuls.

*Location.*—Washington, D. C., and New York City.

*Date begun.*—1914.

*Results.*—General compliance with regulations being secured.

*Assignment.*—C. L. Marlatt, Lester E. Palmer, H. B. Shaw.

*Proposed expenditures, 1918-19.*—\$100.

#### **Cotton:**

*Object.*—To guard against the introduction of the pink bollworm and other cotton pests with imported cotton.

*Procedure.*—Issuance of permits to import and licenses to purchase, use, and store foreign cotton; securing proper reports of arrival from importers and customs officials; providing for the inspection, disinfection, and certification of cotton at port of entry; and keeping records of importations, disinfection, and distribution of such cotton. Since March 10, 1916, all foreign cotton has been disinfected under the supervision of an inspector of the Department of Agriculture prior to entry, and the ports of entry are limited to northern cities. As an additional precaution, all users of imported cotton in the South are required to safeguard their premises by thorough screening or fastening of windows, doors, and other openings in the warehouses or storerooms and opening and cleaning rooms. Furthermore, all users of imported cotton are required to destroy the picker waste from such cotton by burning.

*Cooperation.*—Customs officials and American consuls and postmasters.

*Location.*—Washington, D. C., and ports of entry concerned.

*Date begun.*—1915.

*Results.*—General compliance with the regulations is being secured. A method of disinfecting cotton with hydrocyanic-acid gas has been devised whereby it is possible to penetrate to the innermost parts of a bale and destroy all contained insect pests. As a result of this method, there are now in active operation adequate fumigation plants at the ports of Boston, New York, Newark, San Francisco, and Seattle.

*Assignment.*—C. L. Marlatt, Lester E. Palmer, R. I. Smith, H. B. Shaw, Frederick Maskew, A. G. Webb.

*Proposed expenditures, 1918-19.*—\$30,500.

#### **Cottonseed Products:**

*Object.*—To guard against the introduction of the pink bollworm and other cotton pests with cottonseed products.

*Procedure.*—Issuance of permits; securing proper reports from importers and customs officials of arrival; and providing for inspection to determine freedom from contamination with raw cotton seed before release.

*Cooperation.*—Customs officials.

*Location.*—Washington, D. C., and ports of entry concerned.

*Date begun.*—1917.

*Results.*—General compliance with the regulations is being secured. All cottonseed products imported are thoroughly inspected before being released.



*Assignment.*—C. L. Marlatt, Lester E. Palmer.  
*Proposed expenditures, 1918-19.*—\$1,240.

### **Indian Corn:**

*Object.*—To guard against the introduction of injurious corn diseases.  
*Procedure.*—Issuance of permits, securing proper reports from importers and customs officials of arrival, and providing for sterilization by steam at port of arrival of corn thus imported.  
*Cooperation.*—State inspectors and customs officials.  
*Location.*—Washington, D. C., and ports of entry concerned.  
*Date begun.*—1917.  
*Results.*—All corn imported from the regions covered is properly sterilized.  
*Assignment.*—C. L. Marlatt, Lester E. Palmer, A. G. Webb.  
*Proposed expenditures, 1918-19.*—\$1,000.

### **Citrus Fruits:**

*Object.*—To guard against the introduction of citrus canker.  
*Procedure.*—Issuance of permits; securing proper reports from importers and customs officials of arrival; and providing for inspection at port of entry.  
*Cooperation.*—State inspectors and customs officials.  
*Location.*—Washington, D. C., and ports of entry concerned.  
*Date begun.*—1917.  
*Results.*—All fruit imported from the regions covered is thoroughly inspected before being released.  
*Assignment.*—C. L. Marlatt, Lester E. Palmer, A. G. Webb.  
*Proposed expenditures, 1918-19.*—\$1,000.

**Total, Control of Entry of Plants and Plant Products under Regulation,**  
 \$51,840, including \$14,040 statutory.

[Regulation.]

## **FOREIGN PLANT QUARANTINES.**

### **Foreign Plant Quarantines:**

*Object.*—To prevent, under existing quarantines, the entry of plant material affected with white-pine blister rust, potato wart, Mexican fruit fly, avocado weevil; the pink bollworm of cotton, European pine-shoot moth, citrus canker and other citrus diseases, *Sclerospora maydis* and other diseases of Indian corn and certain closely related plants, insect enemies and plant diseases of sugar cane, the sweet-potato weevil, and the banana-root borer; and to provide for like control by quarantine of any new danger that may arise. Eleven such quarantines, covering the subjects enumerated above, are now in force.  
*Procedure.*—The quarantines are promulgated after due notification and hearing. These quarantines prohibit the entry of the articles covered, and their enforcement is effected largely by cooperation with the Treasury and Post Office Departments, which greatly reduces the cost of control. Foreign notification is effected through the State Department. Cooperation in the checking of violations is also obtained through the official inspectors of the several States acting in the capacity of collaborators of the board.  
*Cooperation.*—Customs officials and postmasters.  
*Location.*—Washington, D. C., and ports of entry concerned.  
*Date begun.*—1912.  
*Results.*—Practical prohibition effected of articles covered; exceptional instances of entry followed up and goods destroyed.  
*Assignment.*—C. L. Marlatt.  
*Proposed expenditures, 1918-19.*—\$3,000.

[Regulation.]

## **DOMESTIC PLANT QUARANTINES.**

### **Domestic Plant Quarantines:**

*Object.*—To prevent, under existing quarantines, further distribution within the United States of the Mediterranean fruit fly and melon fly,



the gipsy moth and brown-tail moth, date-palm scale insects, the pink bollworm of cotton, insect enemies and plant diseases of sugar cane, white-pine blister rust, the sweet-potato weevil, and insect enemies of banana; and by future quarantine to control any new pest that may appear. Nine such quarantines, covering the subjects enumerated above, are now in force.

*Procedure.*—Promulgation of quarantine after due notification and hearing; provision for enforcement of the regulations governing inspection, disinfection, and certification.

*Cooperation.*—State commissioners of agriculture and horticulture, State inspectors, postmasters, and particularly the Bureau of Entomology of this department.

*Location.*—Washington, D. C., with branch stations in districts particularly concerned, including the New England States; Webb County, Tex.; Yuma, Maricopa, and Pinal Counties, Ariz.; Riverside and Imperial Counties, Cal.; all States east of and including Minnesota, Iowa, Missouri, Arkansas, and Louisiana; and Porto Rico and Hawaii.

*Date begun.*—1912.

*Results.*—These quarantines are now in full operation with adequate inspection service, and the further spread of the pests enumerated under "Object" is either prevented or greatly retarded.

*Assignment.*—C. L. Marlatt.

*Proposed expenditures, 1918-19.*—\$5,000. (The cost of the enforcement of the gipsy moth and brown-tail moth quarantine and the Mediterranean fruit fly and melon fly quarantine is met from specific appropriations made to the Bureau of Entomology of this department.)

#### [Research.]

### PLANT QUARANTINE INVESTIGATIONS.

#### Plant Quarantine Investigations:

*Object.*—Investigation of insect and plant-disease conditions as a basis for needed quarantine action.

*Procedure.*—When it is brought to the attention of the Federal Horticultural Board that a dangerous plant pest liable to be imported into the United States occurs in some foreign country, or has already obtained a limited foothold in the United States, if the additional information needed before intelligent quarantine action can be taken can not be promptly furnished by the bureau of the department concerned, qualified experts are detailed to make the necessary studies and investigations.

*Cooperation.*—Various bureaus in the Department of Agriculture, other scientific bureaus of the Government, the related officials of the several States, foreign officials, and the experts and associations or individuals concerned.

*Location.*—These investigations are necessarily of a temporary nature and to meet the immediate need. A list of such research or investigative work hitherto undertaken is given in the paragraph entitled "Results."

*Results.*—(1) During 1918: Surveys were made in Texas and in Mexico to determine the distribution of the pink bollworm of cotton in those regions.

(2) Prior to 1918: Studies of fruit-fly conditions in Mediterranean countries, Bermuda, and Mexico were made, which have furnished the basis for quarantine control. The distribution and importance of powdery scab and other potato diseases in Europe and the Dominion of Canada, and in relation to domestic quarantine in Maine and in Clinton and Franklin Counties, N. Y., were determined, and later surveys to ascertain possible distributions in other States had an important bearing on the lifting of the domestic potato quarantines. Life-history studies of the pink bollworm of cotton were carried on in Hawaii as a basis for the regulation of the movement of Hawaiian cotton. Surveys were made in Pennsylvania, New Jersey, and New York for *Laspeyresia molesta*, the new peach insect from Japan; also of cotton fields in the vicinity of Texas cotton oil mills which had received Mexican seed to determine whether or not the pink bollworm had obtained a foothold, and of the principal cotton-growing regions of Mexico to determine the extent of the occurrence of the pink bollworm in that country.

*Assignment.*—Experts of Federal Horticultural Board and other branches of department (temporary).



*Proposed expenditures, 1918-19.*—\$2,500 (exclusive of the special sums for survey and investigative work in the United States and Mexico in connection with the control of the pink bollworm of cotton).

**Total, Enforcement of the Plant-Quarantine Act,** \$74,800, including \$26,500 statutory (regulation, \$71,840; research, \$2,960).

## PREVENTING THE ENTRANCE AND ESTABLISHMENT OF PINK BOLLWORM OF COTTON.

[Regulation.]

### Border Control Work:

*Object.*—To prevent the movement of cotton and cotton seed from Mexico into the United States, including the regulation of the entry into the United States of railway cars and other vehicles and freight, express, baggage, or other materials from Mexico and the inspection, cleaning, and disinfection thereof to prevent the entry of the pink bollworm.

*Cooperation.*—Customs officials, United States consuls, and public health officials of the State of Texas.

*Location.*—El Paso, Del Rio, Eagle Pass, Laredo, and Brownsville, Tex.

*Date begun.*—1917.

*Results.*—The enforcement of the quarantine and of the restrictions on the entry of railway cars and other vehicles, freight, express, and other materials from Mexico into the United States.

*Assignment.*—C. L. Marlatt, R. Kent Beattie.

*Proposed expenditures, 1918-19.*—\$50,000 (plus an estimated unexpended balance of \$2,000 from the \$50,000 continuing appropriation made available by the agricultural act for the fiscal year 1918).

### Survey Work in Mexico and Extermination of Local Infestations in Mexico Near the Border of the United States:

*Object.*—To determine the distribution of the pink bollworm in Mexico and to exterminate local infestations in Mexico near the American border.

*Procedure.*—The cotton-growing regions of Mexico will be inspected, as far as practicable, to determine the present distribution of the pink bollworm so as to furnish the basis for possible efforts to exterminate this pest in Mexico. Efforts will be made to clean up any local infestations of pink bollworm near the American border.

*Cooperation.*—Owners of ranches and the Mexican Government or local Mexican authorities.

*Location.*—Lerdo, Durango, Mexico.

*Date begun.*—1917.

*Results.*—The surveys hitherto conducted indicate the presence of the pink bollworm at only three points in Mexico, namely, the Laguna district, a few ranches near Allende, some 25 miles south of Eagle Pass, and Santa Monica, just across the border opposite Del Rio, Tex. In cooperation with the Mexican Government and the owners of the properties, steps are being taken to control the two latter points of infestation. The Laguna district is the main cotton-producing area of Mexico and is now generally infested. Quarantines have been declared covering this district by the Government of Mexico, and a plan of operation looking to an ultimate effort to exterminate the insect has been formulated. The pink bollworm has not been found in the Matamoras district opposite Brownsville, which is the principal cotton-producing area in Mexico contiguous to the United States.

*Assignment.*—C. L. Marlatt, August Busck.

*Proposed expenditures, 1918-19.*—\$25,000.

### Surveys and Inspection in Texas or Other States to Detect Infestation, and Conduct of Control Measures:

*Object.*—To prevent the further establishment and spread of the pink bollworm of cotton in the United States and to effect its extermination both in the United States and in Mexico.

*Procedure.*—Cotton fields in Texas, particularly the districts surrounding the points which were found infested in 1917, will be inspected in order to detect any new infestation. The department will cooperate with the State of Texas in the prevention of the growth of cotton in the infested areas of



1917, now by proclamation declared cotton-free areas. Any points of infestation which may be found elsewhere in Texas or in any other State will be cleaned up and safeguarded, in cooperation with the State concerned. The department will also cooperate with the Mexican authorities in such control measures for the extermination of the pink bollworm as shall be determined to be practicable from surveys showing distribution.

*Cooperation.*—Texas and other States and the Mexican Government.

*Location.*—Texas and possibly other States, with headquarters at Houston.

*Date began.*—1917.

*Results.*—A total of 8,794 acres of cotton land in and surrounding the known infested areas in eight counties in Texas has been cleaned of standing and scattered cotton. The cotton gins in this section, some 20 in number, have also been subjected to a thorough cleaning, with destruction of remaining and scattered seeds. All cotton seed grown in the infested area has been collected and milled under supervision, and the lint cotton has been shipped to foreign countries via Galveston. In addition, extensive surveys have been made adjacent to the infested areas.

*Assignment.*—C. L. Marlatt, W. D. Hunter, W. W. Evans, F. S. Puckett.

*Proposed expenditures, 1918-19.*—\$400,000.

[Research.]

**Investigative Work in Mexico or Elsewhere as a Basis for Control Measures:**

*Object.*—To make a biological investigation of the pink bollworm as a basis for control measures.

*Procedure.*—The life history and habits of the insect in Mexico will be determined by the prosecution of careful biological studies, and cultural and other control measures will be developed.

*Cooperation.*—Bureau of Entomology, Department of Agriculture of Mexico, and cotton planters.

*Location.*—Lerdo, Durango, Mexico.

*Date begun.*—1918.

*Results.*—A station has been established and fully equipped at Lerdo, and preliminary investigations of the pink bollworm are now under way.

*Assignment.*—C. L. Marlatt, W. D. Hunter, August Busck, U. C. Loftin, K. B. McKinney, W. K. Hanson.

*Proposed expenditures, 1918-19.*—\$25,000.

**Total, Preventing the Entrance and Establishment of Pink Bollworm of Cotton, \$500,000 (regulation, \$475,000; research, \$25,000), plus approximately \$2,000 unexpended balance from the agricultural appropriation act for the fiscal year 1918.**



## MISCELLANEOUS.

### LIVE-STOCK PRODUCTION IN CANE-SUGAR AND COTTON DISTRICTS.

[Research.]

#### Experiments in Live-Stock Production in Cane-Sugar and Cotton Districts:

*Object.*—To determine the best methods of producing live stock on a commercial scale in the cane-sugar and cotton districts.

*Procedure.*—For the purpose of conducting experimental work to determine the cost of producing different kinds of live stock, a farm between New Iberia and Jeanerette, La., consisting of 500 acres, has been divided into four subdivisions or small farms, one devoted to the production and finishing of beef cattle, one to the production of hogs, another to dairy cattle, and a fourth to the production of mules and to the feeding of the work animals on the farm. These farms are to be kept entirely distinct in every respect. It is planned to utilize to the greatest possible extent pasturage, supplemented with crops to be grazed off by the animals, using the minimum amount of purchased feed or feed from the barns.

It is proposed to establish crop rotations and to determine what methods of handling the animals will be most economical, dealing with animals in rather large numbers. All the knowledge available about the production of crops and the feeding of animals will be applied on these farms for the purpose of making a definite determination of the commercial possibilities of live-stock production in that region.

*Cooperation.*—Work organized and undertaken cooperatively by the Department of Agriculture and the Louisiana Experiment Station.

*Location.*—Jeanerette, La.

*Date begun.*—1914.

*Results.*—The farm has been laid off in pastures and plats for various forage crops. The pastures have been seeded to grasses and clovers, and crops in the various rotations are being planted in their proper season. Fences have been erected. An office building, pump house, tool shed, horse and mule barn, jack shed, hog feed house, 13 hog cots, 2 beef-cattle barns, 4 concrete silos, 4 wooden silos, 6 negro cabins, and 3 dwelling houses for the superintendent and his assistants have been built. The work stock for the place includes mares and mules. The mares are used for breeding purposes. In 1914-15 two carloads of steers were fed on cane tops and whole cane, and the animals sold. In 1915-16, 100 head of cattle were fed on silage made from cane tops, corn, sorghum; corn, sorghum and legumes; corn and soy beans; and corn and sorghum. This experiment was repeated in 1916-17 and in 1917-18, with Japanese cane as an additional roughage.

A breeding herd of beef cattle, consisting partly of native stock and partly of Herefords, has been purchased. A dairy barn has been erected, a herd of 13 registered and 16 grade Jersey cows established, and experiments begun to determine the cost of producing a gallon of milk and the cost of raising dairy heifers. Tests made of various crops for hog raising included sweet corn and cowpeas, sweet corn, field corn and cowpeas, field corn and soy beans, and sweet potatoes. The greatest gains were made with field corn and cowpeas.

*Assignment.*—These investigations are under the supervision of the following committee appointed by the Secretary of Agriculture: W. A. Taylor, chief of the Bureau of Plant Industry; B. H. Rawl, chief of the Dairy Division, Bureau of Animal Industry; and W. R. Dodson, director



of the Louisiana Experiment Station, Baton Rouge, La. J. R. Quesenberry, of the Bureau of Animal Industry, has immediate charge of all the work of the station, but is directly responsible to the committee.  
*Proposed expenditures, 1918-19.—\$44,000.*

[Extension.]

**Live-Stock Extension Work in Louisiana:**

*Object.*—To disseminate information relative to the best methods to be used in producing live stock in the cane-sugar and cotton districts of Louisiana. The lines to be covered will include beef cattle, hogs, horses and mules, poultry, dairying, and forage crops.

*Procedure.*—The best information now available regarding live-stock production will be disseminated among the farmers, through demonstrations and in other ways, by live-stock specialists. Later, when the results of the experiments conducted on the live-stock farm at New Iberia become available, this information will be carried to the farmers in a similar manner.

*Cooperation.*—This work is organized and directed cooperatively by the Department of Agriculture and the extension division of the Louisiana State University. On the part of the department, the work is carried on by the Bureaus of Animal Industry and Plant Industry, in cooperation with the States Relations Service.

*Location.*—Throughout the cane-sugar and cotton districts of Louisiana.

*Date begun.*—1914.

*Results.*—Last year 32 hog, 28 poultry, and 28 beef-cattle demonstrations were organized in cooperation with county agents. As fast as the demonstrations produce visible results they are used as centers around which the residents of the community are brought together at informal meetings to observe what is being done. The dairy agent assisted in the construction of 17 silos, 8 milk houses, and 13 dairy barns. One dairy barn was erected on a fair grounds to serve as a model and a demonstration. Assistance was given in the selection of 253 head of dairy cows and 23 pure-bred bulls. Herd records were made in connection with 20 herds. The records obtained enabled the dairymen to dispose of unprofitable cows and increase the income from the herd. In one case the profits were increased \$29 a cow per year.

At the State fair demonstrations of milk testing, butter making, etc., were given. The forage-crop agent has introduced proper cropping systems on the farms where the various cattle, hog, and poultry demonstrations are made. The live-stock extension force assists at public meetings, locating animals for breeding purposes, etc.

*Assignment.*—W. R. Perkins, leader of live-stock extension work, under the direction of W. R. Dodson.

*Proposed expenditures, 1918-19.—\$16,000.*

**Total, Live-Stock Production in Cane-Sugar and Cotton Districts, \$60,000**  
 (research, \$44,000; extension, \$16,000).

[Research.]

**EXPERIMENTS IN DAIRYING AND LIVE-STOCK PRODUCTION IN SEMIARID AND IRRIGATED DISTRICTS.**

**Experiments in Dairying and Live-Stock Production in Semiarid and Irrigated Districts of the Western United States:**

*Object.*—To investigate the problems encountered in establishing the industries of dairying and meat production in the semiarid and irrigated sections of the United States, particularly with reference to the effective utilization of the forage and grain crops produced in those regions.

*Procedure.*—It is proposed to inaugurate these investigations in the Great Plains area at five points where the Bureau of Plant Industry is now operating field stations for the investigation of problems of crop production, viz, Dalhart, Tex., dairying, and meat production with beef cattle and hogs; Mitchell, Nebr., meat production with hogs; Ardmore, S. Dak., dairying, and meat production with beef cattle and hogs; Newell, S. Dak., dairying, and meat production with beef cattle, hogs, and sheep; and



Huntley, Mont., dairying, and meat production with hogs, sheep, and poultry. The general field work in live-stock production will be in charge of the Animal Husbandry Division and the field experiments in dairying in charge of the Dairy Division, Bureau of Animal Industry. The local responsibility will in each case be centered in the farm superintendent. At each place a competent animal husbandman will have charge of the animal-husbandry investigations, and at four places dairy herds will be maintained with a dairy husbandman in charge of each herd. The size of the herd in each case will be no larger than is necessary for the proper investigation of the special problems undertaken. Most of the feed and some of the equipment will be furnished, without additional cost, by the field stations maintained by the Bureau of Plant Industry. Such feed and equipment as are not so furnished will be purchased.

*Cooperation.*—The work will be organized and directed by the committee on cooperation between the Bureau of Plant Industry and the Bureau of Animal Industry, subject to the approval of the chiefs of the two bureaus, and in cooperation with the State experiment stations which are now cooperating at these field stations.

*Location.*—Dalhart, Tex., Mitchell, Nebr., Ardmore, S. Dak., Newell, S. Dak., and Huntley, Mont.

*Date begun.*—1916.

*Results.*—Dairying: A dairy barn, milk house, herdsman's cottage, two silos, one concrete and one wooden hoop silo, a shelter, and sewer system have been constructed at Ardmore, S. Dak., and at Huntley, Mont. It is expected to begin building operations at Dalhart, Tex., in the near future. A manure pit and a pit silo will also be constructed at Ardmore. A dairy herd, consisting of 12 pure-bred Holstein-Friesian and eight grade cows and a pure-bred bull, is located at Ardmore, S. Dak., with a dairy herdsman in charge; and a similar herd has been established at Huntley, Mont., with a herdsman in charge. Experimental work will be started in the feeding and breeding of dairy cattle at each of these stations.

Live-stock production: Buildings for animal-husbandry work have been completed at Ardmore, S. Dak., and Huntley, Mont. At Huntley experiments have been conducted with different grain rations as supplements to alfalfa pasture and comparisons made of barley and corn for feeding hogs and of single and divided alfalfa pastures. At Newell, S. Dak., experiments have been conducted in carrying brood sows through the summer months on alfalfa pasture; also experiments with beets as a food for swine. Some sheep are being maintained at Huntley, Mont., and at Newell, S. Dak.

*Assignment.*—Committee on cooperation between the Bureau of Plant Industry and the Bureau of Animal Industry: E. C. Chilcott, chairman, C. S. Scofield, and F. D. Farrel, of the Bureau of Plant Industry; and B. H. Rawl and G. M. Rommell, of the Bureau of Animal Industry.

*Proposed expenditures, 1918-19.*—\$40,000.



## SUPPLEMENT.

### PROGRAM OF EMERGENCY ACTIVITIES OF THE UNITED STATES DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEAR 1919.

The work of the Department of Agriculture under regular funds will be supplemented during the fiscal year 1919 by special emergency appropriations made available by Congress for the purpose of increasing the production, promoting the conservation, and improving methods of marketing and utilization of food.<sup>1</sup> The projects to be conducted under emergency funds are as follows:

#### OFFICE OF THE SECRETARY.

##### GENERAL ADMINISTRATION.

The enlarged activities of the department during the emergency due to the war with Germany necessarily have resulted in a great increase in the administrative work. Its prompt handling necessitates the employment of additional assistance, not only in the immediate office of the Secretary but also in the offices of the three Assistant Secretaries, the chief clerk's office, other branches of the Office of the Secretary, and in connection with the legal and accounting work. Under this project provision is made for the payment of the salaries of two Assistant Secretaries and also for the employment of necessary clerical and other emergency assistance and for office supplies, equipment, and miscellaneous expenses incident to the emergency activities.

##### *Proposed expenditures, 1918-19:*

Secretary's office-----	\$16,764
Office of Assistant Secretaries-----	33,220
Solicitor's office-----	3,880
Disbursing office-----	13,536
Office of inspection-----	300
Chief clerk's office-----	8,720
	<hr/>
	76,420

##### RENT.

On account of the great increase in the number of employees of the department in the city of Washington, incident to the emergency work, additional office accommodations are necessary.

*Proposed expenditures, 1918-19.—\$25,000.*

#### PUBLICATION AND INFORMATIONAL WORK.

The work under this project includes the preparation, printing, and distribution of emergency leaflets, circulars, bulletins, and posters; increasing the circulation of the Weekly News Letter to special temporary lists; supplying information in readily available form to daily newspapers, country weeklies, the agricultural press, and certain classes of trade journals; and other publication and informational activities of an emergency character. The work of the Division of Publications and of the Office of Information has greatly increased since the existence of a state of war was declared, and it is necessary that additional assistance and equipment be provided in order that they may keep pace with the demands made upon them.

<sup>1</sup> The figures given in the Supplement represent expenditures as contemplated on July 1, 1918. Since then conditions have materially changed, and the amounts actually to be expended under many of the projects will be considerably less than the figures herein indicated.



*Proposed expenditures, 1918-19:*

Office of Information-----	\$5, 560
Division of Publications-----	29, 440
Emergency printing-----	200, 000
	<hr/>
	235, 000

**AGRICULTURAL EXHIBITS.**

This work consists of the preparation, shipment, installation, and demonstration of exhibit material for use at fairs, expositions, and in other ways, illustrating improved methods of food production, conservation, marketing, and utilization. It is estimated that the exhibits at various fairs during the past fiscal year were viewed by approximately 2,000,000 persons. There has been a constantly increasing interest in the exhibits of the department, which during the past year have related almost entirely to conservation and production activities.

*Proposed expenditures, 1918-19.*—\$43,020.

**ASSISTANCE IN SUPPLYING FARM LABOR.**

In order to deal systematically and effectively with the farm-labor problem, the department has been working in cooperation with the Department of Labor and with appropriate State agencies. It has placed in nearly every State in the Union, in touch with the local agencies, the best available man (1) to make surveys of farm-labor conditions; (2) to bring about fuller cooperation in the utilization of labor among farmers in the same community; (3) to assist in shifting labor from one community or one State to another; and (4) to bring into service kinds of labor not heretofore fully or regularly employed in farming operations, such as boys of high-school age with some knowledge of farming.

*Proposed expenditures, 1918-19.*—\$162,000.

**Total, Office of the Secretary, \$541,440.**



## BUREAU OF ANIMAL INDUSTRY.

### ERADICATION OF CATTLE TICKS.

During the past year, in addition to the regular appropriations, this work received support from funds made available under the food production act. It is planned to continue during the present year the emergency activities already under way. Meetings will be held for the purpose of demonstrating the construction and use of dipping vats and the preparation of arsenical dips and outlining the steps to be taken in properly organizing the eradication campaigns in the various localities. The importance of the tick-eradication work, especially in the present emergency, needs no emphasis. From the beginning of the work in 1906 up to December 31, 1917, 379,312 square miles of territory had been placed in the tick-free area and released from quarantine. During the fiscal year ended June 30, 1917, 40,111 square miles were released, and during the period from July 1 to December 31, 1917, 67,308 square miles were released. On January 1, 1918, there still remained under quarantine 349,253 square miles.

*Proposed expenditures, 1918-19.—\$61,610.*

### ERADICATION OF HOG CHOLERA.

The work of the Bureau of Animal Industry looking to the prevention, control, and eradication of hog cholera is a very important factor in the campaign to stimulate increased pork production. The bureau will maintain in a majority of the States a force of competent veterinarians to cooperate with and assist the regulatory authorities and also to give instructions to county agents and others, through lectures, demonstrations, or otherwise, in methods of control, with a view to the dissemination of such information to farmers. Last year the work was conducted in the principal hog-raising States of the Middle West on a State-wide basis, while other States in which swine production is less important received such attention as the extent of the industry demanded. The work for the present fiscal year contemplates a continuance of the campaign in the 31 States already covered and its extension to five additional States. During the past four years losses from hog cholera have been reduced over 50 per cent, and it is estimated that as a result of the department's activities \$35,000,000 is being saved to the farmers of the country annually.

*Proposed expenditures, 1918-19.—\$202,965.*

### ERADICATION OF ABORTION, INFLUENZA, STRANGLES, ETC.

It is estimated that the losses from contagious abortion aggregate \$20,000,000 annually, while the losses, direct and indirect, from influenza, which affects horses and mules, amount to approximately \$15,000,000 yearly. Anthrax and blackleg also are responsible for large losses to live-stock owners. Very satisfactory results have already been accomplished in connection with the control of these diseases.

During the past year veterinary inspectors were assigned to 15 of the Eastern and Southern States to work in cooperation with live-stock owners and officials in the control of contagious abortion. This work will be continued during the present fiscal year and extended to the States west of the Mississippi River.

In cooperation with State authorities efforts are being made to control influenza in every horse-producing State in the country, and the results indicate that it will be possible greatly to reduce the losses from this disease, with a corresponding increase in the supply of horses and mules for war and domestic purposes. This work has been of decided value to the War Department in connection with the selection and transportation of horses and mules.

*Proposed expenditures, 1918-19.—\$175,000.*

### PRODUCTION OF BEEF CATTLE.

In cooperation with the States Relations Service of this department and the extension divisions of the State agricultural colleges, beef-cattle specialists will be placed in different sections of the country to advise and assist cattlemen and



farmers in (1) the saving by proper selection and redistribution of cows and heifers needed for breeding purposes; (2) the use of more high-class bulls on farms and ranges and better methods of management in order to secure a larger percentage of calves; and (3) the preparation of permanent pastures, building of silos, and the selection of such rations as will utilize to the fullest possible extent farm roughages and other feeds hitherto regarded as unsuitable for food purposes. In the movement of cattle from the drought-stricken areas in the Southwest last year 150,000 head, mostly cows and heifers, were placed on farms and ranges in the Southeast. It is estimated that there is in the Southeast this year sufficient feed to take care of between 400,000 and 500,000 cattle in addition to the number normally provided for. It is planned to extend this work greatly during the present year.

*Proposed expenditures, 1918-19.—\$105,000.*

### **LIVE-STOCK PRODUCTION IN THE GREAT PLAINS REGION.**

A careful study of the situation in the Great Plains region during the past year indicates the desirability of placing the agriculture of that section as far as possible on a live-stock basis. If the large crops of feed which were produced there during years of sufficient rainfall had been stored in silos the drought which caused such large losses during 1917 probably could have been borne without serious difficulties. Straight-crop farmers in that region have had nothing to carry them over periods of drought. If they had live stock and means to support such stock they could tide over these periods. The only way in which this can be satisfactorily done is to utilize silos on an extensive scale and put up such roughage as can be cured.

The situation in all the drought area from the Mexican border to the Canadian boundary is one which should receive close and persistent attention. Rains have come in time to insure a good crop in 1918, and the time is especially favorable to direct the activities of the department and of the colleges toward the development of a rational system of agriculture, based on live stock, in the entire area. A strong campaign will be inaugurated for the construction of silos, especially of the pit type, on every farm where the conditions are favorable. Any farmer who has an equity in his property should be able to get sufficient credit to put in a pit silo after the crop is in sight.

*Proposed expenditures, 1918-19.—\$100,000.*

### **PRODUCTION OF PORK.**

The stimulation of pork production in the United States to meet war requirements is essential. Pork constitutes more than one-half of all the meat produced in the country, and it is the mainstay of the ration of the laboring man and the soldier. The need for augmenting the supply of fats is also particularly acute, and animal fats can be produced more quickly by increasing the number of hogs than in any other manner. The needs of the country are ascertained sufficiently far in advance so that a definite program may be planned and each State allotted its share in this program. The increases asked from the different States vary from 5 per cent in West Virginia to 50 per cent in Missouri. In each State called upon for an increase in pork production a leader is appointed to represent jointly the department and the extension division of the State agricultural college in the work. This leader may have one or more assistants. The services of swine breeders and farmers are engaged for short intensive campaigns to carry the program into every section of the State. In the corn belt the organization of pig clubs is a minor part of the program, while in the South this phase of the work is of major importance.

*Proposed expenditures, 1918-19.—\$150,000.*

### **PRODUCTION OF POULTRY.**

The object of this work is to produce a large supply of poultry and eggs for domestic consumption in order to release larger quantities of beef and pork for the use of our Army and the allies. Every effort should be made to encourage the production of poultry on general farms and in back yards in order to turn waste material into food for human consumption. It is highly important that the poultry stocks of the country be maintained at the point where it will be possible not only to meet the demands for poultry products from European



countries for a considerable period after the war but also to furnish the necessary breeding stock to replenish their depleted supply.

During the past year the principal attention of the department was given to the great poultry-producing sections of the Middle West because of the opportunity afforded for securing the largest and most immediate results. The response by poultrymen has been quite general, and helpful cooperation has been received from women's organizations and commercial associations. The agricultural and general press also is lending valuable assistance, and the work is being further advanced through educational exhibits at a number of the largest poultry shows throughout the country. This work will be continued during the fiscal year 1919, in cooperation with the State extension forces, and extended so as to include practically every section of the country.

*Proposed expenditures, 1918-19.—\$129,600.*

### PRODUCTION OF SHEEP.

That mutton and wool production in this country can be increased greatly admits of no doubt. This can be accomplished by developing sheep husbandry on farms, especially in the Eastern and Southern States. The department is aiding in the transfer of sheep from those sections of the country where there is a shortage of feed, or where range is no longer available, to those regions where the conditions are favorable for sheep production. There is room for a greater expansion of sheep production in the settled farming areas, and this result can be secured without in any way diminishing the supplies of other animal products. With the emergency funds available during the past year specialists were placed in the following sections to stimulate the production of sheep: Minnesota, Wisconsin, North Carolina, Georgia, Florida, Louisiana, Nebraska, and the Upper Peninsula of Michigan. With increased appropriations for the current year, the work is being extended to other States where it is clear that satisfactory results can be secured.

*Proposed expenditures, 1918-19.—\$60,000.*

### MAKING COTTAGE CHEESE ON THE FARM.

Cottage cheese is a very cheap substitute for meat and its food value is approximately equal to that of meat. In almost all sections of the country the quantity of meat consumed on the farm could be considerably reduced if cottage cheese and other homemade dairy products were used more liberally. Much skim milk which is now fed to live stock could be used to better advantage as human food. The experience of the department during the past year clearly indicates the desirability of carrying on an active campaign in rural communities to interest farm women in the making of cottage cheese. It is believed that effective results can be secured in this way. With the emergency funds available this year an agent will be assigned to each State to demonstrate proper methods of making cottage cheese and to give definite information regarding its use. These agents will carry direct to the home-demonstration forces the results of the investigations of the Dairy Division along this line, and the work will be done through and in close cooperation with the extension authorities.

*Proposed expenditures, 1918-19.—\$52,950.*

### UTILIZATION OF CREAMERY BY-PRODUCTS.

It is estimated that, with the proper utilization of the skim milk and buttermilk obtained incident to the manufacture of creamery butter, it will be possible to add annually approximately 2,000,000,000 pounds to the food supply of the Nation in the form of cottage cheese. These by-products also could be used in the manufacture of condensed skim milk, a wholesome and nutritious food, the demand for which is greatly increasing, as well as casein, which is now very useful in the arts and may later become valuable as a food. The work of the current fiscal year contemplates the employment of 25 experienced creamery men for a period of six months for the purpose of assisting creamery operators to devise methods for the proper care of these by-products, both on the farm and in transit, and to give instructions in the utilization of such by-products in the manufacture of foods.

*Proposed expenditures, 1918-19.—\$21,850.*

**Total, Bureau of Animal Industry, \$1,058,975.**



## BUREAU OF PLANT INDUSTRY.

### PURCHASE AND SALE OF SEED.

Provision is made under the food production act for procuring, storing, and furnishing seed for sale to farmers for cash at cost in restricted areas where special need arises. This work is under the direct charge of a committee known as the committee on seed stocks, appointed by the Secretary of Agriculture. In carrying out its work the committee obtains by all available means information relative to the supply of and demand for seed throughout the country and disseminates this information to farmers, seedsmen, and others who are directly concerned with crop production.

During the past fiscal year the department supplied seed to farmers for planting upward of 1,000,000 acres, for which a total of \$2,951,000 was expended. The appropriations available for this purpose included revolving funds of \$2,500,000 under the food production act and \$4,000,000 under the urgent deficiency act of March 28, 1918. The results of the work may be summarized as follows:

In the fall of 1917 the crop conditions indicated that there might be an emergency in the supply of seed in parts of Texas, Oklahoma, Kansas, North Dakota, and Montana, and also in the northern part of the corn belt, where frosts and early freezes damaged corn to such an extent as to seriously reduce the available supply of seed corn. A long-continued drought in Texas made it appear advisable for the department to provide a considerable quantity of seed in order that that section's seed supply might be insured for the 1918 crop.

The sum of \$750,000 was therefore expended for the purchase of seed corn, cotton, sorghums, and peanuts, to be held for such needs as might develop in Texas.

The conditions affecting the sorghum seed supply in Kansas and Oklahoma threatened to cause a shortage of good seed for planting purposes, and the department expended \$215,000 for sorghum seed, including sweet sorghums and grain sorghums, and Sudan grass for the purpose of supplying the needs of farmers who would have difficulty in getting seed from other sources.

In western Montana and eastern North Dakota the drought of 1917 was so severe as to cause almost a complete crop failure, and it became evident early in the season that farmers and commercial agencies would not be able to supply seed of various important crops for planting in the spring of 1918. The department purchased seed of oats, barley, and flax for the general territory to the amount of \$960,000 and shipped it to sections where it was most needed and where it could be made available to farmers under the terms of the law.

The supply of good seed corn in the northern part of the corn belt was seriously reduced because of unfavorable climatic conditions in the early fall and winter, and, in order to assist in making adequate supplies available, the department expended the sum of \$1,026,000 for the purchase and sale of seed corn to farmers for cash at cost. Approximately 55,000 bushels of such seed were sold for first planting; a reserve for replanting was also purchased, but, because of very favorable conditions for the germination and early growth of corn, only a small proportion of the reserve stock was used.

*Proposed expenditures, 1918-19.—\$6,500,000.*

### CEREAL-SMUT ERADICATION.

The department is conducting an active campaign to control the ravages of grain smuts, which cause annual losses aggregating 90,000,000 bushels, and incidentally to prevent other cereal diseases subject to control by chemical treatment of the seed. The work is being carried on by a staff of 40 field assistants assigned to different sections of the United States and working under the direction of leaders qualified by experience and training to direct this particular type of extension work. These field assistants, in conjunction with county agents or other farm



advisers, are conducting seed-treatment demonstrations before farmers' organizations, movable schools, county and township high schools, chambers of commerce, and other State agencies. The seed-treatment phase of the campaign is followed by an extensive and thorough field survey, the purpose of which is to ascertain the results of seed treatment as compared with those observed in fields where seed treatment was not practiced; to collect information as to distribution of and losses caused by preventable cereal diseases; address farmers' organizations; give instructions to individual farmers as to methods of seed treatment; conduct field demonstrations, illustrating in unorganized sections of the country the value of seed treatment as a means of increasing crop production; and determine what sections of the country are in greatest need of instruction and other assistance as regards the control of cereal diseases. The field survey will be followed by the fall seed-treatment campaign, in which the results obtained during the field survey will be put into direct use. The major emphasis is being placed upon the treatment of preventable smuts of wheat, oats, barley, and rye, and grain sorghums.

The work thus far conducted in 22 States probably has resulted in the treatment of 50 per cent of all the seed wheat, oats, and barley sown. This means a saving of not less than 10,000,000 bushels of wheat, 25,000,000 bushels of oats, and 4,000,000 bushels of barley. It is believed that another year's work will result in a reduction of the present annual losses by from 50 to 60 per cent.

*Proposed expenditures, 1918-19.—\$110,000.*

### PEANUT CONSERVATION AND UTILIZATION.

The peanut is becoming of such great importance as a food crop that every effort should be made to conserve and utilize it to the best advantage. Since its production is being undertaken over extensive areas by persons who are relatively unfamiliar with the crop, it is important that assistance be rendered the demonstration agents by experienced men in securing the adoption of the best methods of harvesting, curing, threshing, storing, and handling; to increase the utilization of the crop for the production of food products; and to utilize the hay and other by-products of the industry in the maintenance of milk and meat producing animals. Considerable loss usually occurs in all new regions because of lack of knowledge of the proper methods of handling the peanut crop. The work for the present year will be undertaken in Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Texas, Arkansas, and Oklahoma, in close cooperation with the extension forces in those States.

*Proposed expenditures, 1918-19.—\$15,000.*

### CONTROL OF COTTON, TRUCK, AND FORAGE CROP DISEASES.

Under an allotment from emergency funds efforts were made during the past year by specialists in plant diseases to locate for bean growers in the Northeastern States a supply of disease-free seed and to determine the soundness of seed potatoes in the Central and North-Central States. Cooperation has also been maintained with the food-products inspection service of the Bureau of Markets through the detail of pathologists to study diseases of vegetables in the terminal markets, to advise the inspectors relative to their identification and effect upon keeping quality, and to take steps towards lessening these losses. At the request of the War Department, men also have been detailed to advise depot quartermasters relative to the inspection of perishables for the presence of plant diseases, and a considerable saving has been effected through their work.

The department is facing a greatly increased demand from farmers, through their farm bureau organizations and county agents, for practical assistance in the control of plant diseases, which cause enormous annual losses. For all the diseases included under this project effective control measures already are available. It is planned to conduct the work in close cooperation with the State extension agencies and to expand the pathological force of the Bureau of Plant Industry to a point where it can effectively meet the demands made upon it. The plans for the current year include demonstrations along the following lines:

(1) *Cotton diseases.*—Active work looking to the introduction of varieties resistant to wilt and to the control of anthracnose, two diseases which cause large losses annually.



(2) *Truck-crop diseases*.—Demonstrations in the control of (a) potato late blight, the most serious plant disease in the Northeastern States; (b) seed-borne potato diseases, such as mosaic, leaf-roll, blackleg, and scab; (c) sweet-potato diseases (it is estimated that the department's work last year resulted in saving \$100,000 in two southern counties alone); (d) bean diseases, which last year caused serious losses in Michigan, New York, and other bean-growing States, and which can be controlled in large measure through the use of disease-free and disease-resistant seed; (e) tomato wilt, which causes losses aggregating approximately 200,000 tons of tomatoes annually, and tomato leaf-spot, which is responsible for the loss of at least 500,000 tons, which losses are entirely preventable through the adoption of proper control measures; (f) nematode diseases, which are especially destructive in the South, attacking cotton and forage plants as well as truck crops; (g) southern garden diseases, such as tomato wilt, cabbage yellows, root-knot, etc., which are especially discouraging to home gardeners and frequently make the summer cultivation of these vegetables impossible; and (h) pathological investigations of vegetables during the processes of marketing, looking to the determination of the diseases which cause the most serious losses and the institution of control measures at the source of production; also cooperation with the War Department by giving advice relative to diseases affecting perishable vegetables purchased for the Army.

*Proposed expenditures, 1918-19.*—\$117,550.

### LOCATION OF IRISH-POTATO SEED STOCKS.

This project has for its object a general survey of the United States for the purpose of locating, improving, and making available a larger supply of high-quality seed potatoes for commercial purposes than is now available, and the determination of the suitability of certain stocks and varieties for seed purposes in the various potato-producing areas. Encouragement will be given to growers to adopt the home seed-potato plot method of improving their seed stocks. The inspection and roguing of commercial fields will have a very considerable value to the southern truck grower, who each year must depend upon the northern grower for his seed supply, purchase of which is usually made without any previous knowledge of the quality of the stock bought. The work is carried on by potato specialists, cooperating with specialists in plant diseases. Considerable quantities of seed potatoes were located and inspected during the past year in Maine, New Hampshire, Vermont, Massachusetts, Indiana, Wisconsin, Minnesota, and Colorado. The need for locating as large a quantity of good seed potatoes as possible in the autumn of 1918 for use the following year is very urgent. No other factor is of more vital importance to the potato industry than that of good seed. The plans for the present year contemplate a campaign in 19 States, including a continuation of the work in the States already covered.

*Proposed expenditures, 1918-19.*—\$30,000.

### PLANT-DISEASE SURVEY.

It is highly essential that the department have available definite information relative to the occurrence and severity of the more important plant diseases as an aid in the control of serious epidemics, especially of diseases of grain and truck crops. It is especially important to determine the range of a new destructive disease of corn recently introduced from the Orient, the regions where potatoes and beans are seriously injured by plant diseases and where control work must be undertaken, and similar factors necessary for the proper development of the campaign against the smut and rust diseases of wheat, as well as diseases of other crop plants.

The \$10,000 allotted to the plant-disease survey from regular funds has been only sufficient to enable the department to maintain in Washington and the States a skeleton organization for gathering data by correspondence, but does not permit of active war emergency work. During the past fiscal year it was possible with an allotment of \$18,500 under the food production act to extend the work somewhat in the field. The State plant pathologists in nearly every State have made collaborators of the department, and, with them as local leaders, cooperative relations rapidly are being established with a large body of pathological workers, thus enabling the department to collect a large volume of information on diseases of food crops of great value in emergency disease-



control operations and fostering a spirit of cooperation among pathologists, which is of special importance at this time. This work is also conducted in close cooperation with the various pathological offices of the Bureau of Plant Industry.

The value of the plant-disease survey as a war emergency agency may be summarized under two heads—(a) general watch service regarding diseases of important food crops in the various States, and (b) special surveys on particular diseases of crops.

(a) *General watch service.*—Both Federal and State pathologists have found the services rendered by the plant-disease survey during the past season to be very valuable and have emphasized the importance of continuing and extending it. It is hoped to keep in sufficiently close touch with the general disease situation in each State so that warning may be given of the more unusual or important developments of diseases of the principal crops, thus clarifying the disease situation in each State and affording a sound basis for the emergency work undertaken by State and Federal pathologists.

(b) *Special surveys.*—The various pathological offices of the Bureau of Plant Industry have requested assistance from the plant-disease survey forces either (1) by gathering disease data bearing on their control operations, especially in those regions which their own field men can not cover without taking them away from their special duties in extension and control work, or (2) by gathering data on diseases of important crops which merit immediate attention as war emergency measures but which can not profitably be undertaken as definite projects without preliminary field study. As illustrations of special surveys urgently needed at the present time may be mentioned the leaf rusts of wheat and other cereals, root and stalk diseases of corn, ergot of rye and other grains and grasses, late blight of potato, sweet potato, onion, and tomato diseases, rust of beans and of asparagus, soy-bean diseases, sugar-beet nematode troubles, and sugar-cane disease.

*Proposed expenditures, 1918-19.*—\$23,000.

### CASTOR-BEAN PRODUCTION AND UTILIZATION.

The oil of the castor bean has been found to be particularly desirable in the lubrication of airplane motors. It happens to be one of the few oils not soluble in gasoline and is affected but little by changes in temperature. It is therefore particularly useful in these motors. While formerly an important crop in certain sections of Oklahoma, Kansas, Missouri, and Illinois, the culture of castor beans had been practically abandoned in this country in recent years, so that growers experienced in handling the crop were no longer available. To meet the war needs in this direction the War Department has found it necessary to contract for the growing of about 100,000 acres of castor beans, and this department has undertaken to act in a general advisory capacity in supervising the agricultural work incidental to the production of the crop.

Incidentally, it is also desired to collect reliable economic and agronomic data on the production and utilization of castor beans, which will both facilitate their production in 1919, if necessary for war purposes, and afford reliable information with regard to future prospects for their cultivation in this country in view of the greatly enlarged demand for castor oil in various industries.

The work is distributed over a wide area in the South. This large field is divided into four districts, to each of which has been assigned an agronomist who will collaborate with county agents in advising farmers, keep in contact with persons holding contracts with the Signal Corps, and advise them regarding the best methods to pursue to secure the desired crop of castor beans, and at the same time fully safeguard the interests of the Government and the small grower. Valuable data on the castor-bean crop made available during the progress of this undertaking will be collected. Technical phases of the utilization of castor oil and of the press cake and other by-products will be investigated.

*Proposed expenditures, 1918-19.*—\$20,000.

### MAINTENANCE OF FIELD-BEAN SEED SUPPLY.

The purpose of this project is to improve the bean industry of the United States by developing methods which will insure seed of higher productivity,



true to name, and less subject to disease; this to be accomplished through inspection of seed, tests for germination, and maintenance of seed plots to insure seed true to type and of greater productive capacity. Investigation has shown that in order to insure the best results in the production of field beans it is necessary to use seed of local harvest and of undoubted viability.

In cooperation with the State forces, bean surveys will be made in order to determine the available quantity of germinable seed of suitable varieties in each important growing region. An effort will be made to stimulate the maintenance by growers of a seed plot from which to secure seed of local production true to variety and, through the elimination of unproductive plants, to increase the acreage yield of beans; also to encourage the use of cultural practices proved to be most advantageous for the control of anthracnose and other bean diseases.

*Proposed expenditures, 1918-19.—\$10,000.*

### FIELD SUPERVISION OF WAR-GARDEN WORK.

The work of the department in connection with home gardens is primarily under the direction of the States Relations Service, cooperating with the Bureau of Plant Industry. The latter bureau furnishes the garden specialists to assist the extension forces in the planning of the garden work and to give advice regarding the handling of crops and as to the varieties that are most suitable for small gardeners. It is their function to coordinate and direct these activities by providing suitable, safe instructions for the making and maintenance of home vegetable gardens, through publications and by direct contact with the extension agencies in the States, as well as by furnishing timely suggestions for the press.

*Proposed expenditures, 1918-19.—\$7,500.*

### PRODUCTION OF CEREALS AND GRAIN SORGHUMS.

An active field campaign is being conducted to secure the adoption of the best methods of producing cereals and grain sorghums. Several specialists have been assigned to the spring-wheat areas, especially in those States which have been asked to extend greatly their acreages, and to those regions where there has been a large increase in rye production during the past few years. Special campaigns are being conducted to secure the more general adoption of the best methods in the production of flax, buckwheat, barley, and grain sorghums. In all cases the experts and assistants assigned to this project are working as special advisers to the county agents in selecting the varieties of these crops best suited to the different regions and in securing the most economical use of labor and the adoption of the best methods of planting, handling, and storing the crops.

The possibility of growing flax as a winter crop in the Southwestern States from Texas to California has been studied and found practicable under present prices. Extension of the winter-rye area into the States of the northern Great Plains has been encouraged, with gratifying results. Preliminary surveys were made in June, 1918, to encourage the production of drought-resistant grain sorghums in Kansas, Texas, and Arizona. Surveys were made of fields of Turkey wheat in Iowa, of Kanred in Kansas, and of Early Baart wheat in Arizona and California. Publicity has been given to attempts to exploit at exorbitant prices such poorly adapted or little known wheats as Alaska, Titanic, Polish, Burbank, etc. An improved type of drill for sowing winter wheat in furrows, which it is believed will prevent winterkilling, has been developed.

*Proposed expenditures, 1918-19.—\$53,250.*

### SUGAR-BEET NEMATODE WORK.

The sugar-beet nematode occurs in destructive numbers in California, Utah, Idaho, and Colorado, where it has been definitely located. It undoubtedly is responsible for serious losses in other localities. The losses in California from this pest, according to the best figures obtainable, are approximately \$300,000 annually. A survey of Utah and Idaho, recently completed, shows that the sugar-beet nematode occurs in no less than 10 sugar-beet areas in those States. A conservative estimate of losses to growers in these areas, based on the pre-



vailing price of beets, amounted in 1917 to over \$300,000; the loss to sugar companies, based upon yield of sugar per acre and price of sugar, amounted to nearly \$900,000; making a total loss to the growers and sugar companies in Utah and Idaho of approximately \$1,200,000. Aside from the financial loss involved, the decreased output of sugar in Utah and Idaho from this cause is estimated at 40,000 tons. These losses may be expected to increase steadily from year to year unless active steps are taken to control this pest.

In many of the areas in which the nematode is found the infestation is slight at present, and if effective steps are taken at once the pest undoubtedly can be held in check, at least to the extent of permitting the growing of sugar beets with profit in such regions. It is proposed to make a thorough survey of the sugar-beet sections to locate the areas which are or may be infested; study the effect of crop rotation, cultural methods, fertilizers, and other factors that bear upon the propagation and spread and upon the control of the nematode; conduct field and plat experiments for the purpose of determining the most practical means of control; and give advice to farmers regarding control measures, crop rotations, use of irrigating water, and other practices that should be followed when growing beets on badly infested lands.

*Proposed expenditures, 1918-19.—\$10,000.*

### PATHOLOGICAL INSPECTION OF FRUITS DURING PROCESSES OF MARKETING.

The object of this project is to carry on the necessary pathological work, in cooperation with the inspection service of the Bureau of Markets, to determine the condition of fruits on the markets and during processes of marketing, including the initial shipping points; to discourage the shipment of fruit which is likely to spoil in transit or on the market; to give advice and information to the market inspectors of the Bureau of Markets regarding the diseases and decays of fruits; and to investigate and identify fruit diseases on the market in order to aid in their prevention. The inspection will include deciduous orchard fruit, such as apples, peaches, pears, plums, cherries, and quinces; citrus and other subtropical fruits; grapes, cranberries, strawberries, and other small fruits. This work is essential to the effective administration of the food-products inspection law. It is highly technical in character and entirely different from, but supplements in a very definite way, the work of the Bureau of Markets under this law.

*Proposed expenditures, 1918-19.—\$18,000.*

### CONTROL OF A NEW SUGAR-CANE DISEASE.

A destructive disease of sugar cane, known as "mottling," appeared on the island of Porto Rico about four years ago, but, so far as the department knows, it has not yet appeared in any other part of the world. The latest information at hand is that the disease is continuing to spread and that there are localities in the western end of the island where the growing of cane has been entirely abandoned. In four years the disease has spread from a few patches here and there until it now covers about one-fourth of Porto Rico and threatens to wipe out the sugar-cane industry of the island, which has now reached a total production of 400,000 tons annually. Specialists from this department will be assigned to cooperate with the pathologist of the insular experiment station in working out and securing the adoption of practical methods of control. The possibility of the occurrence of the disease in Florida at the present time also will be investigated.

*Proposed expenditures, 1918-19.—\$20,000.*

### PRODUCTION OF RICE.

Results of a recent general survey of Porto Rico by the Bureau of Plant Industry indicate that this island, which now buys on an average of \$4,500,000 worth of rice from the United States each year, has a sufficient area suited to this crop to produce at least 50 per cent of its annual rice requirements. This department can render material service in developing rice production in Porto Rico in cooperation with the insular experiment station. It is proposed to maintain a nursery at Mayaguez. The selected seed and hybrids produced



there will be distributed throughout the island. Cultural, irrigation, and varietal tests are to be conducted on sugar-cane plantations in different parts of the island.

In certain sections of Georgia, South Carolina, Alabama, and Florida, where the normal rainfall is sufficiently heavy during the summer months to provide the necessary water, without irrigation, for the cheap production of rice, it is believed that much good might be accomplished by encouraging the culture of this crop for local and home use. This work does not contemplate any general extension of the rice-producing area, but the demand for rice is increasing and there are small areas on many farms which could be advantageously utilized for rice production.

*Proposed expenditures, 1918-19.—\$5,000.*

**Total, Bureau of Plant Industry, \$6,939,300.**



## BUREAU OF ENTOMOLOGY.

### GENERAL SUPERVISION OF EMERGENCY INSECT-CONTROL WORK.

This project provides for the general supervision and systematization of the various extension activities of the Bureau of Entomology in connection with emergency insect-control work, in cooperation with the States Relations Service and through that service with the extension divisions of the State agricultural colleges.

*Proposed expenditures, 1918-19.—\$3,000.*

### CONTROL OF CEREAL AND FORAGE INSECTS.

Assistance is rendered growers by giving instructions in methods of controlling insects injurious to cereal and forage crops. The extension work under this project, as well as other insect-control projects under the food production act, is carried out from the regional standpoint rather than by States, and the organization is sufficiently flexible to permit the concentration of men in any region where insect outbreaks may occur. Specialists have been appointed who are especially fitted to conduct work of this character. Co-operative arrangements have been made, through the States Relations Service, with the directors of extension in the respective States. In sections where the work is most needed instruction and demonstrations are being given in applying proper cultural methods, such as the destruction of hibernation quarters, dates of planting, tillage, rotation, fertilization, time of harvesting, and the use of sprays, poison baits, or other insecticides, with a view to minimize insect depredations.

During the fall of 1917 a force of 7 men carried on a campaign in the upper Mississippi Valley wheat regions in the control of the Hessian fly. This was followed by a survey to locate potential grasshopper outbreaks. During the past spring an extensive campaign in the control of the chinch bug was carried out, and a most successful campaign was conducted against grasshoppers throughout the upper Mississippi Valley region and the Pacific Northwest. An additional campaign is under way in the West and Northwest on the control of the alfalfa weevil and the clover flower midge. Educational work is also being concentrated on white-grub, wireworm, jointworm, and cornborer control.

*Proposed expenditures, 1918-19.—\$55,000.*

### CONTROL OF STORED-PRODUCT INSECTS.

An extensive survey has been made throughout the Southern States to ascertain the extent of damage being done by pests of stored products and the possibility of improving these conditions. The losses to grain and other food products in storage through insect depredations, particularly in the South, are frequently greater than those caused by insects to the growing crops. It is believed that a large portion of these losses can be prevented through the adoption of proper methods of control. Meetings of warehousemen, seedsmen, growers, and others are held, in connection with the State extension agencies, and instructions given in the construction of granaries and fumigation bins and in other methods of control.

During the past year an extensive campaign was carried on in Florida, Georgia, and Louisiana for the control of the corn weevil, with the object of improving the conditions of harvesting and storing the crop to prevent damage by this insect.

*Proposed expenditures, 1918-19.—\$22,000.*



## CONTROL OF VEGETABLE AND TRUCK-CROP INSECTS.

Special field agents cooperate with the county agricultural agents by giving instructions in the use of insecticides, such as sprays, powders, mashies, etc., in the application of correct cultural methods, such as destruction of hibernation quarters, rotation, and time of planting, and in the proper methods of harvesting and storing.

During the past year special attention was given to general garden insects in New England and to the control of insect pests in the commercial trucking sections of the lake regions of New York and Wisconsin. An extensive educational campaign has also been conducted among the truckers of Long Island, Virginia, and North Carolina. General truck-crop work is well under way in southern California and in Washington and to a lesser extent in the lower Mississippi Valley and in Florida.

*Proposed expenditures, 1918-19.—\$35,000.*

## CONTROL OF THE SWEET-POTATO WEEVIL.

The sweet-potato weevil recently has become a serious menace in portions of Georgia, Alabama, Mississippi, Louisiana, and Texas, a region which produces about one-half of the entire sweet-potato crop of the United States. In view of the importance of this crop, which at present prices represents an annual value of more than \$100,000,000, it is believed that every effort should be made to reduce the losses caused by this pest. During the past fiscal year, under an allotment of \$30,000 from the appropriation made available by the food production act, a preliminary survey was made to determine the distribution of the insect and a campaign inaugurated to disseminate information as to methods of control. This survey indicates the desirability of materially extending the work already under way with a view to bring about a gradual reduction of the area infested and to encourage the more general adoption of effective control measures. In order to render this work most effective, investigations will be conducted regarding the life history and habits, methods of dissemination, and alternate food plants of the weevils.

The sweet-potato weevil is probably of Chinese origin and was brought to this country on imported sweet potatoes. It has been known in the Gulf region, notably in Florida and Louisiana, for 40 years. The damage from it in this section has at times been quite severe but more or less intermittent. The insect has come into great prominence, especially during the past year, by reason of its sudden spread and development throughout the principal sweet-potato growing districts of the South. The State of Florida has undertaken a vigorous campaign to eradicate the weevil in that State.

*Proposed expenditures, 1918-19.—\$30,000.*

## CONTROL OF DECIDUOUS-FRUIT INSECTS.

### Control of Deciduous-Fruit Insects (General):

Efforts are being made to increase fruit-crop production by giving instructions to orchardists and others, through personal visits, demonstrations, lectures, and otherwise, in spraying and other methods of insect control, with a view to minimize insect damage. A number of special field agents are engaged in carrying on the work in the control of deciduous-fruit insects in various sections of the country. Hundreds of meetings have been held, many demonstrations in orchard spraying have been made, and thousands of farmers have received instructions in applying the improved methods developed by the department.

*Proposed expenditures, 1918-19.—\$25,000.*

### Control of the Oriental Fruit Moth.

Inspéctors have been appointed to cooperate with State officials in making a thorough survey of orchards, nurseries, and premises to ascertain the present distribution of the oriental peach moth, an insect pest recently imported from Japan and now known to occur in various parts of the Eastern States, as a basis for determining practical eradication or control measures. This insect is particularly injurious to most of our important fruits, such as the peach, plum, cherry, apricot, apple, pear, and quince. Scouting work will be done in all the States where deciduous fruits are grown to any extent, and special attention will be given to those States where infestations are known to exist or where



there is reason to believe the insect has been introduced on imported Japanese nursery stock.

*Proposed expenditures, 1918-19.—\$20,000.*

**Total, Control of Deciduous-Fruit Insects, \$45,000.**

### CONTROL OF CITRUS-FRUIT INSECTS.

Instructions are given to growers in spraying, fumigation, and other remedial measures looking to the control of insects attacking the orange, lemon, and grapefruit, with the object of promoting increased production of these fruits. An extensive campaign is being conducted in southern California for the control of mealy bugs and scale insects, and similar work with citrus-fruit insects is under way in Florida.

*Proposed expenditures, 1918-19.—\$10,000.*

### CONTROL OF INSECTS INJURIOUS TO LIVE STOCK.

Practical field demonstrations are made by specialists of the bureau, working in cooperation with the county agents and other extension forces in the States concerned, in methods of controlling insects injurious to live stock. One specialist is carrying on a campaign in Texas, Missouri, and Tennessee in the control of ox warble, bot fly, screw worm, cattle lice, and chicken pests; another is covering Louisiana; and a third man has finished a similar campaign in Nebraska and Oklahoma, and will conduct work in New Mexico, Arizona, and California during the summer.

*Proposed expenditures, 1918-19.—\$20,000.*

### CONTROL OF RICE INSECTS.

Instructions in improved cultural practices, such as destruction of hibernation quarters, proper methods of applying water to the rice fields, methods of harvesting, and the application of insecticides, are given by demonstrations and otherwise to rice growers at meetings arranged for by the county agents or independently in counties where no agents have been assigned.

*Proposed expenditures, 1918-19.—\$3,000.*

### CONTROL OF SUGAR-CANE INSECTS.

Two specialists are assigned to give instructions to growers in the control of sugar-cane insects, in order that the beneficial results of control measures developed by the bureau may be put into practical effect. These consist of demonstrations in proper cultural methods, fertilization, harvesting, and the use of insecticides, with the aim of increasing sugar production through a more effective control of the insects attacking cane.

*Proposed expenditures, 1918-19.—\$9,000.*

### EXTENSION WORK IN BEEKEEPING.

The need of extension work in beekeeping is especially acute at the present time in view of the relation of increased honey production to the sugar supply. The amount of wasted nectar is so great that it is believed every effort should be made to further commercial beekeeping as rapidly as possible. With the regular appropriations of the Bureau of Entomology demonstrations have been carried on in a limited way. It is planned to enlarge this work through the employment of additional specialists, who will cooperate with the States Relations Service of this department and with the extension divisions of certain of the State agricultural colleges, in order that the practical details of management may be demonstrated as widely as possible and beekeepers instructed so to handle their bees as to secure maximum honey production.

*Proposed expenditures, 1918-19.—\$15,000.*

**Total, Bureau of Entomology, \$247,000.**



## BUREAUS OF CHEMISTRY, MARKETS, AND PLANT INDUSTRY.

### PREVENTION OF PLANT-DUST EXPLOSIONS AND FIRES.

The large number of explosions and fires in grain mills and elevators which the country has experienced and which have caused large losses of grain and property, and in some cases loss of life, emphasizes the necessity of taking all feasible steps to control them. With an allotment of \$25,000 from the funds made available by the food production act, the Bureau of Chemistry has during the past year assisted operators of mills and elevators in the removal of dangerous dust conditions and the elimination of possible cause of explosions and fires. The work has produced very satisfactory results. Meetings were held at various points throughout the country and the methods of prevention which have proved effective were demonstrated by lantern slides and motion-picture reels, and actual dust explosions were produced before the audiences by specially devised laboratory equipment. In the conduct of this work the department has been cooperating closely with the Food Administration and also with the National Board of Fire Underwriters, insurance commissions and inspectors. State officials, and other agencies concerned with fire prevention. It is essentially a conservation campaign and should result not only in the saving of large quantities of grain but also in preventing the loss of human life.

Similar work also was conducted in connection with the prevention of explosions and fires in threshing machines. The dry season of 1916 in the West was marked by an unusually large number of smut explosions. The devices originated by the department in cooperation with the several State experiment stations have been found to be satisfactory in preventing smut and other plant-dust explosions, and threshers properly equipped have in no case suffered either from explosions or fires. The activities of the department in connection with the prevention of plant-dust explosions and fires involve the close and effective cooperation of three bureaus of the department, namely, the Bureau of Chemistry, Bureau of Markets, and Bureau of Plant Industry. In the work for the present fiscal year each of these bureaus will deal with a particular phase of the problem, as indicated in the statement of subactivities which follows.

#### Thresher Explosions and Fires:

There is urgent need for continuing the demonstrations of the efficiency of the appliances for preventing smut-dust explosions and fires in threshers inaugurated by the Bureau of Chemistry. These demonstrations will be extended to other areas likely to suffer from a prevalence of smut, especially in the Great Plains, the Southwest, and the Northwest.

The work of the past season with reference to smut explosions indicates the need of a further improvement in the devices for ridding the machines of the smut dust. Since the cleaning fans scatter the smut spores in the vicinity of the threshing machines, this may result in increasing the smut infection of grain in nearby fields. The development of methods for destroying the spores is therefore very important. As fast as methods are developed they should be demonstrated in connection with the demonstrations of explosion and fire prevention devices. This phase of the work will be under the direction of the Bureau of Plant Industry.

In addition to reducing the danger of explosions and fires, the cleaning of the grain in the threshers by the special fans has resulted in an improvement in the grade of the grain, and consequently a better price. The demonstration of this improvement in the grade of grain is one of the important steps in securing the adoption of protective devices on the threshers, and accordingly it is important that the work be continued. This feature of the project will be conducted by the Bureau of Markets.

*Proposed expenditures, 1918-19.*—\$17,500 (Bureau of Chemistry, \$5,000; Bureau of Plant Industry, \$5,000; Bureau of Markets, \$7,500).



**Mill and Elevator Explosions and Fires:**

It has been shown that grain-dust explosions in grain elevators and storage buildings can be largely prevented by devices somewhat similar to some of those used in threshing machines. The feasibility of adapting these devices to grain elevators and storage warehouses has been demonstrated during the past season, and it is planned to continue this work during the present fiscal year. The Bureau of Chemistry, which has worked out the necessary devices, will have the leadership in this work. The Bureau of Markets, because of its close contacts with the grain trade, will be able to render material assistance in demonstrating the methods developed.

*Proposed expenditures, 1918-19.*—\$50,000 (Bureau of Chemistry, \$40,000; Bureau of Markets, \$10,000).

**Cotton-Gin Explosions and Fires:**

Preliminary investigations indicate the probability that the numerous cotton-gin fires of the past year resulted from electric discharges caused by the development of static electricity in operating the cotton gins. It is desirable to test on cotton gins the attachments that have been found successful in preventing similar troubles in threshing machines and to provide for demonstrations of such methods if they should prove to be applicable to cotton-gin protection. The Bureau of Chemistry, because of its experience in developing methods for grain dust and smut explosion prevention, is believed to be in the best position to undertake this work. At the same time, the Bureau of Markets, with its large staff of cotton experts and its close contacts with the cotton trade, will render material assistance in the development of effective methods of control and in demonstrating these methods.

*Proposed expenditures, 1918-19.*—\$7,500 (Bureau of Chemistry, \$6,000; Bureau of Markets, \$1,500).

**Total, Prevention of Plant-Dust Explosions and Fires, \$75,000.** (Bureau of Chemistry, \$51,000; Bureau of Markets, \$19,000; Bureau of Plant Industry, \$5,000).



## BUREAUS OF CHEMISTRY AND PLANT INDUSTRY.

### FRUIT AND VEGETABLE UTILIZATION.

There is great need for a more general conservation, particularly by drying, of food products which can not be satisfactorily and economically utilized in a fresh state because of distance from market or other factors rendering it impracticable to dispose of the products at harvest time. The department has definitely determined the fact that practically all our common vegetables and fruits can be successfully dried and thus converted into nonperishable form, which can be cooked and served when needed, furnishing products of excellent quality whenever reasonable care has been exercised in the preparation of the material.

This project is being approached from two angles. (1) The Bureau of Plant Industry is giving expert assistance in developing the best methods of home drying and other similar forms of fruit and vegetable utilization. This work is restricted to the operations which can be handled upon farms or by individuals and is carried on in close cooperation with the county agents and other representatives of the States Relations Service. (2) The Bureau of Chemistry is attacking the problem of drying from the standpoint of the commercial article and primarily from the standpoint of the large commercial establishments. It is also able, through its knowledge of commercial processes, to assist other offices, especially the extension forces of the department, in the modification of commercial practices to suit the requirements in the drying of garden produce.

Close cooperation is in effect between the Bureau of Chemistry and the Bureau of Plant Industry, and the work has been carefully planned so as to avoid duplication of effort.

*Proposed expenditures, 1918-19.*—\$35,000 (Bureau of Chemistry, \$20,000; Bureau of Plant Industry, \$15,000).



## STATES RELATIONS SERVICE.

### GENERAL ADMINISTRATION OF EXTENSION WORK.

This project provides for the general administration of the emergency work of the States Relations Service, including the office of the director, the chief clerk's office, the publication activities, the purchase of supplies and equipment, and the accounting work.

*Proposed expenditures, 1918-19—\$35,000.*

### EXTENSION WORK IN THE SOUTHERN STATES.

#### Supervision:

General direction and supervision of emergency demonstration work in the Southern States, having in view the dissemination of information from the United States Department of Agriculture, the agricultural collegés, and other approved sources, looking to increased food production, the elimination of waste, and the conservation of food, by educational and demonstrational methods, through district and county agents and others.

*Proposed expenditures, 1918-19—\$90,000.*

#### County-Agent Work:

In this emergency work the method of organization and procedure is similar to that indicated under the regular county-agent project. In some cases where there are counties in a State in which, on account of their financial condition, lack of interest, or for any other reason, it becomes impossible to secure local cooperation, emergency demonstration agents are appointed, to serve in a temporary capacity, covering the territory not possible to cover with the regular organization. Such an agent is sometimes employed as an assistant county agent to work a vacant county adjoining a county where there is a strong, well-trained county agent, who directs him. At the discretion of the State extension director, emergency demonstration agents are sometimes placed within vacant counties, or they are appointed as group agents to serve two or more counties. Among the agents employed under this project some negro agents are included.

The full purpose of the project is to extend and enlarge the work of district and county agents so as to cover the States entirely.

*Proposed expenditures, 1918-19—\$1,333,815.*

#### Boys' Club Work:

This project provides for the appointment of additional assistant county agents for the purpose of rapidly extending the organization and greatly increasing the enrollment of boys in clubs for food and feed production, animal production, etc. The method of organization is the same as that indicated under the regular boys'-club project.

*Proposed expenditures, 1918-19—\$75,300.*

#### Home-Demonstration Work, Including Girls' Club Work:

The plan of work is essentially the same as that indicated under the regular project. Emergency demonstration agents are appointed in additional counties, the intent being to cover the State as far as possible, including the cities. Additional district agents necessary to supervise all the work properly are appointed, part of whose time is devoted to carrying out the general plans of food production and conservation and the elimination of waste. Special urban agents are located in cities of 2,500 population or over, and their work may be organized as an integral part of the regular home-demonstration work. Among the women employed under this project, some negro agents and assistants are



included. On the side of increasing food production, attention is given to home gardens, orchards and small fruits, and the production of poultry and eggs. On the side of conservation and elimination of waste, instructions and demonstrations are given in canning, drying, preserving, pickling, brining, and storing fruits and vegetables in the home; home curing and canning of meats; utilization of food products, such as the making of cottage cheese and butter; care of milk; preparation of foods for the table; selection and use of foods; partial or complete substitution of other foods for meat and wheat flour; prevention of waste; utilization of left-overs; prevention of spoiling of foods from insect damage, moisture, molds, etc., in storage in the home; prescribing of proper diet; etc.

*Proposed expenditures, 1918-19.—\$803,385.*

**Total, Extension Work in the Southern States, \$2,302,500.**

## **EXTENSION WORK IN THE NORTHERN AND WESTERN STATES.**

### **Supervision:**

General direction and supervision of emergency demonstration work in the Northern and Western States, having in view the dissemination of information from the United States Department of Agriculture, the agricultural colleges, and other approved sources, looking to increased food production, the elimination of waste, and the conservation of food, by educational and demonstrational methods, through district and county agents and others.

*Proposed expenditures, 1918-19.—\$134,200.*

### **County-Agent Work:**

The method of organization and procedure followed is similar to that in effect under the regular county-agent work, which this project supplements. Where counties can not be organized with local funds to assist in the work, two or more counties may be grouped into districts with one agent. Additional assistant county-agent leaders will be added to the administrative force in the various States to provide adequate supervision of the work of the agents. In the furtherance of the object of this project the emergency agent will give special attention to the following subjects: (1) Increasing the acreage and yield of the food crops common to the locality; (2) assisting farmers in securing good seed, fertilizers, live stock, credit facilities, and farm labor; (3) effecting cooperative organizations for the economic purchase of farm supplies and the marketing of farm products; (4) eliminating farm waste; and (5) conducting demonstrations illustrative of good agricultural practices.

*Proposed expenditures, 1918-19.—\$1,893,000.*

### **Boys' and Girls' Club Work:**

Extension work for boys and girls, supported by emergency funds, is organized and supervised by the State leaders in charge of work supported by regular funds, the same procedure and method of organization being followed. All the emergency work is correlated and coordinated with the regular cooperative extension work of the various States.

*Proposed expenditures, 1918-19.—\$382,900.*

### **Home-Demonstration Work:**

This work supplements that in progress under the regular project. Urban emergency home-demonstration agents are employed and located in cities with a population of 40,000 or more, who cooperate with existing organizations and create new organizations, where necessary and feasible, for the purpose of giving instruction to city women through demonstrations, lectures, publications, and otherwise on food production, poultry raising, and home gardening in suburban districts; food conservation through canning, drying, and preserving; and the elimination of waste and the utilization of valuable but little used foods.

*Proposed expenditures, 1918-19.—\$1,327,400.*

**Total, Extension Work in the Northern and Western States, \$3,737,500.**

## **HOME-ECONOMICS WORK.**

This work consists of the preparation and issuance of publications of a popular nature on diet and food conservation for use in the emergency demonstrations and in correspondence relating thereto. The publications now in hand



cover only a part of the topics on which the extension workers and the general public should have definite and accurate information. Extension material is needed on many more of the fundamental topics of food selection and preparation in order to keep abreast of the developments of the food situation. The Food Administration, as well as the extension workers of the Department of Agriculture and the State colleges and county and city agencies, are interested in the continuation and extension of this enterprise. In order to provide material for the solution of the war emergency food problems, many tests will be made of methods of cookery of old and new foods and of the possibilities of combining the available food supply into palatable as well as adequate meals, and of the possibilities of avoiding waste. In addition to material constantly needed for current use, data will be accumulated in advance, in order that the department may be able to keep pace with changes in the emergency food situation and supply material promptly.

*Proposed expenditures, 1918-19.*—\$25,000.

**Total, States Relations Service, \$6,100,000.**



## BUREAU OF MARKETS.

### MARKET NEWS SERVICE ON FRUITS AND VEGETABLES.

With funds made available under the food production act 18 or 20 permanent offices and about 100 temporary field stations will be maintained, in addition to the 12 permanent and 50 temporary stations opened before the emergency appropriation became available. With the aid of emergency funds the framework of a complete national machine for the collection and interchange of shipment and market information on fruit and vegetable products of the country has been practically completed. It is estimated that of the 25 crops reported on this year 17 are covered by the emergency appropriation and that the expenses incident to the maintenance of three out of four of the telegraphic circuits now maintained will be paid from emergency funds, as well as the expenses of issuing 7,000,000 of the 10,000,000 bulletins distributed daily.

*Proposed expenditures, 1918-19.—\$500,000.*

### MARKET NEWS SERVICE ON LIVE STOCK AND MEATS.

With regular funds devoted to this work branch offices have been maintained at Boston, New York, Philadelphia, Washington, Chicago, Kansas City, and Omaha. With emergency funds offices have been opened at Fort Worth, Portland (Oreg.), Lancaster (Pa.), Rocky Ford (Colo.), St. Paul, Los Angeles, Denver, Salt Lake City, Pittsburgh, Louisville, St. Louis, Jacksonville (Fla.), San Francisco, El Paso, and New Orleans. In addition, the work of this project has been expanded very materially so as to make it possible to furnish the public with more complete information regarding demand, prices, supplies (including source and distribution), and other conditions affecting the live-stock and meat trade. It is estimated that of the 750,000 market reports which are distributed each month only about 200,000 could be issued without the use of emergency funds.

As a result of a survey of certain feeding and grazing districts much valuable information was obtained during the past year relative to the "in and out" movements of live stock in those districts, the source from which the supply of stockers and feeders is received, the markets to which the finished product goes, the seasons of these movements, and the conditions which influence them. A telegraphic information service has been maintained in the Lancaster, Pa., and Arkansas Valley districts.

*Proposed expenditures, 1918-19.—\$300,000.*

### MARKET NEWS SERVICE ON BUTTER, CHEESE, EGGS, AND POULTRY.

The object of this project is to secure and publish reports on production, market receipts, available market supplies, trade and market conditions, and market prices of dairy and poultry products at country points and in wholesale and retail distributing markets, and other information which may be of value to producers, distributors, and consumers in intelligently directing their sales and purchases of these products.

Since September 1, 1917, monthly reports showing the production for the current month and corresponding month of the previous year of butter, cheese, condensed and evaporated milk, and other manufactured milk products of all classes produced in over 12,000 dairy manufacturing plants in the United States have been issued from Washington. In establishing a market news service on dairy and poultry products, branch offices have been opened at New York, Utica (N. Y.), Boston, Philadelphia, Chicago, Milwaukee, Minne-



apolis, San Francisco, and Portland (Oreg.), and arrangements have been made for the establishment of similar offices in other important wholesale distributing markets. Daily market news bulletins on butter, eggs, and cheese have been issued from the offices established. The Food Administration, War Trade Board, Shipping Board, and other branches of the Government service, and many organizations and individual members of the trade rely to a great extent upon these market bulletins and reports for accurate data relative to the production, market supply, distribution, and values of dairy and poultry products.

*Proposed expenditures, 1918-19.—\$164,000.*

## **MARKET NEWS SERVICE ON GRAIN, HAY, FEEDS, AND SEEDS.**

### **Market News Service on Grain, Hay, and Feeds:**

This work consists of the collection and dissemination of accurate information relative to the stocks, surplus supply available in the immediate future, requirements, and prices of grain, hay, and feed in all parts of the United States; assistance, as far as possible, in relieving congested transportation facilities by encouraging direct shipment from producers to consumers and the avoidance of cross movements; by making available the information mentioned above, reduction in the spread in price between the producer and consumer; giving advice regarding the marketing of grain, hay, and feeds, and rendering special emergency services required in any particular section.

Since the news service was inaugurated in August, 1917, the country has been divided, for the purpose of this work, into ten districts, viz, the North Atlantic, Middle Atlantic, Southeastern, North Central, East Central, West Central, Southwestern, North Pacific, Rocky Mountain, and South Pacific, and field offices have been opened in New York, Richmond, Atlanta, Minneapolis, Kansas City (Mo.), Chicago, Oklahoma City, Spokane, Denver, and San Francisco. In addition to the issuance of its regular reports, a great deal of special work has been conducted. Through the machinery developed for the dissemination of its regular reports it was possible during the past year to assist in saving from starvation thousands of cattle in the drought-stricken area of Texas by rendering a daily news service especially adapted to this exigency. In North Dakota and eastern Montana insufficient feed for stock threatened to cause a crop failure. To assist in alleviating this situation, a temporary office was opened at Bismarck, N. Dak. This office has published daily bulletins, containing definite quotations on feedstuffs delivered at various points in western North Dakota. Owing to threatened serious losses of soft corn, the facilities afforded by this reporting service were utilized to secure specific information for the Director General of Railroads regarding the exact location and quantities of soft corn, the number of cars needed to transport it, and the date on which these cars could be used. On account of the shortage of feed for dairy cattle in the North Atlantic division, a survey was made at the request of the Food Administration to ascertain the amount of feed available, the amount needed, the number of cars of feed in transit to the region affected, and other matters. Assistance has been given the Quartermaster General's office, the Council of National Defense, and other Government agencies, as well as to producers, dealers, and consumers of these products, by furnishing information regarding the location and condition of available supplies of corn, oats, and other grain.

*Proposed expenditures, 1918-19.—\$80,000.*

### **Seed Reporting Service:**

The country has been divided for the purpose of this work into ten divisions and offices have been opened in Minneapolis, Chicago, Kansas City, Atlanta, Spokane, New York, Denver, San Francisco, and Fort Worth. Timely information regarding the movement, supply, demand, price, and quality of seeds produced and consumed in each division is gathered by local representatives, summarized, and transmitted to Washington, where it is published in the "Seed Reporter," the official organ of the Seed Reporting Service and the Department Seed Stocks Committee. This periodical is issued monthly or oftener, if necessary, and is sent free to all growers, shippers, dealers, Federal and State agricultural agencies, and other persons or concerns interested in it.

*Proposed expenditures, 1918-19.—\$70,000.*

**Total, Market News Service on Grain, Hay, Feeds, and Seeds, \$150,000.**



## FOOD AND FERTILIZER SURVEYS OF THE UNITED STATES.

These surveys are being undertaken to secure information regarding the food supply of the Nation, especially the quantity of various important food commodities in the hands of producers, dealers, and other agencies, the relative supply as compared with that of a year ago, and the rate of consumption. In cooperation with the Office of the Secretary, information is obtained regarding the supply and prices of fertilizer materials in the United States.

Surveys have been made of the quantities of raw food products on farms, stocks in the hands of manufacturers, storage concerns, wholesale and retail dealers, and household stocks and household consumption.

An important part of the food-survey work now under way is that done in obtaining reports direct from threshers throughout the United States regarding the actual amount of wheat and other grains threshed. This method represents the only known way of ascertaining the amount of cereals produced aside from that followed in the decennial census. The returns obtained from threshers are to be made immediately available to the Food Administration and are to be used by the Department of Agriculture in conjunction with other information obtained by the Bureau of Crop Estimates. Three comprehensive surveys of commercial stocks have been completed, one under date of August 31, 1917, covering 18 selected items, a second under date of January 1, 1918, covering 86 items, and a third on July 1, 1918, covering 67 items. With the aid of the Bureau of Crop Estimates, information was obtained regarding stocks on hand on farms. Reports of household stocks and household consumption were secured in cooperation with the States Relations Service, and in connection with this survey a special dietary study was undertaken. Since April 1, 1918, monthly reports covering commercial stocks of grains and grain products have been secured from elevators, mills, warehouses, and wholesale dealers in grain and flour, and since May 1, 1918, similar reports covering sugar, rice, condensed milk, certain canned goods, etc., have been secured from wholesale grocers, manufacturers, and warehouses. Special surveys are made at certain seasons. For example, a special survey will be made to ascertain the stocks of potatoes, onions, and cabbage held by dealers and commercial producers on November 1, 1918, and on January 1 and March 1, 1919.

The results of the survey of August 31, 1917, were published in six circulars, in the Office of the Secretary series, regarding the supply in the United States of sugar, lard, and canned salmon, and the commercial stocks of miscellaneous cereal and vegetable foodstuffs, wheat and flour, and miscellaneous animal food products. Since April, 1918, a monthly publication entitled "Food Surveys" has been issued giving the results of the monthly reports referred to above. Special issues also have been published giving in detail the results of the survey of January 1, 1918, and commercial holdings of the more important foodstuffs, not including retail stocks, covered by the survey of July 1.

*Proposed expenditures, 1918-19.—\$300,000.*

## CONSERVATION OF FOOD PRODUCTS IN TRANSPORTATION AND STORAGE.

### Preservation of Fruits and Vegetables in Transportation and Storage:

Specialists in handling fruits and vegetables conduct demonstrational work in producing territories regarding the best methods of handling, packing, and shipping fruits and vegetables so as to cause as little waste from decay and deterioration as possible. Advice is given to producers regarding construction and efficient use of common storage houses for fruits and vegetables. Carriers are urged to use refrigerator cars producing increased refrigeration efficiency and greater protection against freezing damage. Advice and assistance are given regarding the proper construction and design of refrigerator and heater cars.

As a result of these demonstrations, improvements in methods of handling fruits and vegetables when preparing them for shipment are being effected, with consequent reduction of spoilage. Loading methods have been materially improved, making possible not only reduction of losses in transit but heavier loading of cars and the more economical and efficient utilization of equipment. Information is furnished the Railroad Administration relative to proper loading methods, safety minimums, etc., as related to the different crops and sections.

Practically all the refrigerator cars built in the United States within the past 18 months have been of a more efficient type, as they have been built in



accordance with the department's recommendations. Twenty-seven hundred such improved cars have been constructed by one company alone, and practically all rebuilds are of the same improved and standardized design. The refrigerator cars which the Railroad Administration plans to build for the Government during the summer of 1918 also have been designed in accordance with these recommendations.

Methods of protecting perishable food products against freezing in transit have been widely demonstrated, and such improvements have been made as could be installed during one season. Various types of heater cars and methods of heater protection have been tested and demonstrated. The results and recommendations are being furnished to the Railroad Administration to be used as a basis for establishing adequate heater service and freezing protection in transit.

As a result of the car shortage last season, the demand and necessity for storage in producing centers increased greatly, and demonstrations were made in order to induce producers to construct air-cooled storage houses of the maximum efficiency and economy in accordance with plans recommended by the department. In Oregon and Washington 70 additional air-cooled storage houses for apples were erected during the summer and fall of 1917, in accordance with the department's plans. Demonstrations of proper methods of preparing products for storage, methods of placing them in storage, and the proper management of both air-cooled and refrigerated houses, so as to insure the efficient protection of the contents, have resulted in reducing greatly the losses of food products.

*Proposed expenditures, 1918-19.—\$150,000.*

#### **Emergency Traffic and Storage Assistance:**

Transportation specialists are stationed at important transfer and diversion points and large market centers to work in cooperation with shippers, local operating officials of railroads, and receivers and to observe and report upon conditions. This information is transmitted to the Director General of Railroads in order to assist in correcting defects in railroad operation. Assistance is given shippers in securing cars, and an educational campaign is conducted in order to insure the more efficient and speedy loading of cars, elimination of delays in transit, and the reduction of the practice of hauling empty cars. Information is furnished to the Director General of Railroads regarding commodities essential in agricultural production and commodities which should be moved promptly. Reports are issued regarding cold-storage holdings of certain commodities, and information regarding storage space available, defects and inefficiencies in storage plants, and other matters is distributed.

The Director General of Railroads and the Commission on Car Service have been furnished accurate information regarding sections of the country in need of cars to transport agricultural products, fertilizers, insecticides, seeds, agricultural implements, etc. For the use of the Director General estimates have been made of the total number of cars needed to move a particular crop from a particular section, as well as estimates of the average number of cars needed daily for such movement. Shippers and receivers have been urged by letter and wire to use cars more efficiently. Effort has been made to eliminate arbitrary regulations by individual roads seeking to enforce the immediate unloading of perishable products. The Director General of Railroads has been advised of the commodities essential in agricultural production so as to secure the prompt movement of these articles. All complaints and appeals for assistance in connection with the transportation of agricultural commodities which reach the department are handled by this project, and much assistance has been rendered in this way.

Reports are issued regarding the amount of various commodities in cold storage; assistance has been given in effecting the reduction of excessive stocks in storage; cold-storage plants are studied to determine their efficiency, and the Fuel Administration is given information regarding those whose coal consumption is not justified by the results obtained. A comprehensive chart showing in convenient reference form the proper storage conditions for certain perishable products has been prepared for distribution to cold-storage operators and for use by Federal reserve banks in discounting negotiable paper based on cold-storage holdings held by local banks. Information is given to officials of the War and Navy Departments and the Food Administration for the use of British and French purchasing commissions regarding the location of suitable refrigerated space for the storage of such perishable products as they may need.

*Proposed expenditures, 1918-19.—\$79,937.*



**Farm Storage of Sweet Potatoes:**

This work, which is conducted in cooperation with the extension divisions of the agricultural colleges in the South, has been organized to assist the sweet-potato growers in obtaining accurate and detailed information regarding the construction and management of storage houses and the proper methods to be used in harvesting, grading, and curing sweet potatoes.

Demonstrations will be made to show correct methods of harvesting and curing sweet potatoes and the relation of careful handling, suitable containers, and correct temperature and humidity conditions to the safe transportation and storage of the product. Recommendations will be made regarding the construction and management of common storage houses for sweet potatoes, plans and specifications being provided. Educational campaigns will be conducted to stimulate interest among growers in new and improved construction of such storage houses and the proper methods of handling, transporting, and storing sweet potatoes.

It is estimated that the houses built and remodeled during the autumn of 1917, as a result of the department's recommendations, will hold at least 1,000,000 bushels of potatoes and that the value of the potatoes stored in the proper type of house is increased at least 25 cents per bushel over that of sweet potatoes stored in pits. On an average at least 25 per cent of the potatoes stored in pits are lost through decay, as against a loss in storage houses of less than 5 per cent.

*Proposed expenditures, 1918-19.—\$30,000.*

**Total, Conservation of Food Products in Transportation and Storage, \$259,937.**

**MARKET INSPECTION OF PERISHABLE FOODS.**

This service is an extension of the regular project "Market Inspection of Perishable Foods." With the amount to be provided under emergency appropriations, it will be possible to carry on inspection in markets of relatively less importance than those covered under the regular inspection service but which, nevertheless, are in urgent need of work of this kind. If necessary to effect the maximum conservation of perishable food products, the expenses of increasing the service in some of the largest and most important markets will be defrayed from the sum allotted to this project.

*Proposed expenditures, 1918-19.—\$51,000.*

**CITY MARKET SERVICE.**

The city market service developed with funds provided by the food production act has been conducted in nine cities. Local agents collect accurate information on current local supplies and prices of farm produce, special attention being given to that produced near by. This information is published in non-technical form through newspapers and bulletins for the benefit of local producers, consumers, and dealers, in order to furnish data on which the fairness of prices may be judged and by which attention may be directed to the most abundant and most economical foods in the market. Information with reference to improved methods of retail distribution is being assembled and disseminated to dealers and consumers in an effort to make lower retail prices possible and to make it profitable for consumers to perform some of the expensive service which retailers are now asked to furnish.

During the fiscal year 1919 such agencies will be placed in about 15 additional cities. In cooperation with the Bureau of Crop Estimates, a survey of planting plans for truck crops for 1918 and production for 1917 was made in producing territory near six important markets in the early spring of 1918, and the information obtained was given to growers to enable them more intelligently to meet the needs of their markets. In cooperation with the States Relations Service and the Food Administration, a campaign was conducted in order to market the surplus of old potatoes on extremely narrow margins so that they might be sold to consumers cheaply enough to stimulate consumption and avoid threatened waste.

*Proposed expenditures, 1918-19.—\$66,131.*



## DIRECT MARKETING ACTIVITIES.

### Marketing by Parcel Post and Express:

Demonstrations are made regarding the use of parcel-post and express facilities in marketing farm products from producer to consumer direct, in order to conserve small lots of food which can not be marketed profitably through ordinary commercial channels; to bring to the attention of the public the increased possibility of profitably utilizing such facilities on account of the high prices for foodstuffs; and to assist, where advisable, in establishing personal contacts for direct marketing between producers and consumers.

Producers and consumers have been brought into relationship by securing the names of persons interested and desirous of marketing direct and putting them into business relationship with consumers. Cooperative work has been conducted in Philadelphia in connection with the automobile rural-route service established by the Post Office Department. This service has handled food products for consumers and the regular trade distributors in Philadelphia. It has also handled the shipment of mushrooms and tomatoes to New York and other points, thus supplementing the express service when the latter could not make satisfactory deliveries of perishable commodities. A campaign to promote the use of the parcel post has been instituted in and around Jacksonville, Fla., in cooperation with the Post Office Department. Preliminary work has been finished and the actual getting of producers and consumer into business contact has been commenced. In connection with this campaign, a survey of the rural parcel-post motor route from Savannah, Ga., to Statesboro, Ga., has been undertaken in order to determine the maximum possibilities for helpfulness which this route affords to producers of farm products. There has been undertaken also a survey of the rural parcel-post motor route running from Columbus to Zanesville, Ohio, and campaigns for the extension of direct marketing have been inaugurated in and around Boston, Mass., and New York City.

*Proposed expenditures, 1918-19.—\$40,000.*

### Motor Transportation of Farm Products:

Demonstrations will be conducted regarding the possibilities of operating motor-truck marketing routes in specific sections after study has been made of the area to be served, including its present transportation facilities, volume, and character of the products to be hauled, condition of the roads, probable cost per ton-mile of motor service, permanence of the proposed route or routes, local interest in the enterprise, the effect which more efficient transportation service will have on production, and other matters.

As a preliminary to demonstrational work studies of methods and costs of operating motor routes in rural districts have been made in New Jersey, Pennsylvania, western New York, Ohio, Massachusetts, and Maryland. A demonstration motor route from Vineland, N. J., to New York City for the transportation of eggs has been established and is operating with success. Negotiations are under way for the establishment in the near future of other such routes in northern Ohio, western New York, and other districts. Information regarding this matter is being tabulated and compiled for future reference or publication.

*Proposed expenditures, 1918-19.—\$45,100.*

**Total, Direct Marketing Activities, \$85,100.**

## SPECIAL MARKETING ACTIVITIES.

Under this project specialists conduct educational work regarding the best methods of handling, grading, packing, and shipping fruits and vegetables, demonstrate the grades for fruits and vegetables which have been promulgated by the Bureau of Markets, and assist in the formulation of grades for products not so standardized.

Direct assistance is rendered to communities of producers or consumers in the organization of cooperative associations for marketing farm products. Assistance also is given in the organization of consumers for buying in car-lot quantities direct from producers. Urgent requests for assistance of this kind have been received from employees of large manufacturing concerns, railroad companies, etc. In many cases the employers of such persons have expressed a willingness to finance such purchases, to keep books for the organization,



extend warehouse facilities along railroad sidetracks, and, in some cases, to make deliveries with their own trucks.

In connection with the foreign marketing work of the bureau several special investigators may be sent to Europe to work in close cooperation with the consular service and other European officials of the United States Government. If this is done, reports will be forwarded regularly by the investigators both by mail and cable and complete surveys made to develop information regarding post-war demands for guidance now and during the readjustment period.

Grades for peanuts and Bermuda onions have been prepared and published. Recommended grades for strawberries are in course of publication. Work is now being conducted with apples, peaches, peanuts, dry beans, sweet potatoes, and truck crops. Tentative standards for cotton seed have been formulated. Emergency assistance to cooperative organizations and emergency foreign marketing work was not instituted until July 1, 1918.

*Proposed expenditures, 1918-19.—\$109,440.*

**Total, Bureau of Markets, \$1,985,608.**



## BUREAU OF CHEMISTRY.

### POULTRY AND EGG DEMONSTRATIONS.

It is well known that the improper handling and distribution of poultry and eggs cause enormous losses from decay and other damage every year. To improve these conditions demonstrations are made, meetings held, assistance given through literature and correspondence and by personal visits, and centers of information in charge of Government agents are located, preferably in poultry and egg packing houses, receiving stations, warehouses, and other trade establishments.

A special effort has been made to stimulate the development of small packing houses equipped with feeding stations and supplied with refrigeration for storage preliminary to transportation to market. A number of these plants have been built and have served as practical demonstrations to the poultrymen in the surrounding regions. The investigations of the department have shown that poultry fed in them, in accordance with the methods worked out by the Food Research Laboratory, will gain approximately 30 per cent in weight within a period of 14 days. The work, therefore, has a very direct bearing upon the meat supply of the country. After the fleshing process the birds are dressed and shipped in carload lots from the small packing houses with practically no waste or decay. Eggs are also handled in the demonstration plants, chilled immediately on receipt, and shipped under refrigeration, thereby greatly reducing losses from spoilage. Very satisfactory results were secured last year, and the work is being extended and developed during the present fiscal year.

*Proposed expenditures, 1918-19.—\$40,000.*

### SIRUP DEMONSTRATIONS.

In Georgia, Alabama, and Florida there are large areas suitable for the growth of sugar cane for use in the production of sirup. The progress of this industry has been slow because of the technical difficulties involved. One of these is due to the fact that, if concentrated too far, cane juice will crystallize and become unmerchantable. On the other hand, if not concentrated far enough, it will ferment. The second difficulty encountered by the sirup maker is the variability in the flavor and color of his product. Under the regular appropriations of the Bureau of Chemistry methods have been worked out for overcoming these difficulties, and by their adoption it has been possible to produce a sirup that will not crystallize or ferment and that is superior in quality to the ordinary commercial product. With the allotment of \$7,000 under the food production act it has been possible to intensify the demonstration of these methods in an effort to stimulate the production of this valuable sirup. These methods, if followed, will prevent the very serious losses from spoilage of a considerable portion of each year's crop.

*Proposed expenditures, 1918-19.—\$7,000.*

### PREPARATION OF SWEET SIRUPS.

While cane sugar is commonly used as a sweetening agent in crystalline form, there appears to be no reason why solutions of sweet and wholesome sugars should not be used for the same purpose if they were available. The number of plants that yield crystalline cane sugar in amounts that are of industrial importance are few, and only the sugar beet and the sugar cane are of much importance in this respect. On the other hand, there are a great many plants and fruits, as, for example, the grape, which yield sweet juices. These juices always carry a characteristic flavor of the plant source and usually



are considerably colored, but it has been demonstrated in the laboratory that both the color and the characteristic flavor can be removed by the use of active wood charcoal. In this way a sirup can be made from grapes, for instance, which is colorless and quite sweet and without any characteristic flavor other than sweetness to indicate its origin. It is possible that sweet sirups of similar type may also be obtained from other plant sources.

The work proposed under this project will consist of a further study of the preparation of active charcoal and the preparation of sweet sirups from a variety of agricultural products, especial emphasis to be laid upon the production, on a commercial scale, if possible, of sirup from grapes. The present need for sugar and the desirability of finding uses for the large quantities of grapes that have hitherto been used in wine production in the United States emphasize the importance of this work.

*Proposed expenditures, 1918-19.—\$5,000.*

### HANDLING, TRANSPORTATION, AND STORAGE OF FISH.

There is need for the greater utilization of sea foods, the production of which can be increased without any appreciable tax on the common sources of food supply. Under a \$15,000 allotment from the emergency appropriation during the past fiscal year demonstration work was conducted in fish-producing sections, notably the coasts of Florida and North Carolina, to maintain a steady flow of fish in good order to northern and western markets. Similar work is being organized on the Pacific coast. The Bureau of Fisheries, which is stimulating production, is cooperating in this project.

Attention has recently been given to the establishment of fish freezers at certain points on the Gulf coast. Two freezers are now under construction at Fort Myers and Tampa, and three other freezers are planned. It is possible to install such freezers at small cost in conjunction with artificial ice plants already in operation. There are available in enormous quantities in Florida many varieties of small fish suitable for high-grade canned products. With the installation of freezers large quantities of these small fish can be frozen during the flush season and canned after the run is over. Investigations are now under way to determine the feasibility of canning frozen fish and the best methods to use.

The fresh-fish supply last year was short. Transportation conditions make the best of handling imperative. Losses due to decay have been unusually heavy. The advice, assistance, and presence of the Government men on the coasts are a direct stimulus to a greater and better fish supply in the markets.

*Proposed expenditures, 1918-19.—\$20,000.*

### WATERPROOFING LEATHER FOR GOVERNMENT AND FARM USE.

For several years the Bureau of Chemistry has been carrying on investigations regarding the waterproofing of leather for Government and farm use. The funds available for the purpose, however, are very limited, and it has been impossible to prosecute the work as rapidly as its importance justifies. War conditions have emphasized the urgency of the work and make it necessary further to develop it in order to supply information regarding waterproofing and preservative materials needed by the purchasing branches of the Government. It is proposed, with emergency funds, to make careful tests of commercial waterproofing and preservative materials, as well as of the formulas developed by the Bureau of Chemistry, in order to determine their value for waterproofing and their preservative qualities, as well as their freedom from harmful ingredients. These investigations will be of benefit not only to the Army and Navy but also to the farmer and, in fact, wherever leather is used. The department will cooperate with the War Department and the Council of National Defense in the conduct of this work.

*Proposed expenditures, 1918-19.—\$3,000.*

### SERVICEABILITY TESTS OF LEATHER AND LEATHER SUBSTITUTES.

The Bureau of Chemistry has been conducting under its regular funds small-scale investigations to determine the wearing quality of leather and leather substitutes. Recently the cooperation of the War Department and the National Association of Tanners has been secured. With increased funds under emer-



gency appropriations it has been possible to institute on a more adequate scale actual wearing experiments to determine the relative merits of various tan-nages of leather, both sole and upper, and also sole-leather substitutes. This information will be of value to the farmers and the people at large, as it will aid materially in the conservation of raw materials, namely, hides and vegetable tanning materials. It is also urgently needed to assist the War Department in the present emergency in selecting durable and serviceable materials and in preparing specifications therefor.

The existence of a large army provides an excellent and timely opportunity to conduct these experiments under conditions favorable to their successful conclusion and also to obtain the service history of a large number of samples, which data and samples will be of inestimable value in developing a machine for determining the serviceability of soling materials.

*Proposed expenditures, 1918-19.—\$6,000.*

#### UTILIZATION OF WOOL-SCOURING WASTES.

There are approximately 500,000,000 pounds of unscoured wool used in this country annually. This contains approximately 75,000,000 pounds of wool grease, worth normally \$2,250,000 (at the present time, \$10,000,000), and 25,000,000 pounds of potassium carbonate, worth normally \$750,000 (at the present time, \$15,000,000). Practically all the potassium carbonates and the greater part of the wool grease are allowed to waste. The potassium carbonate is urgently needed in glass, soap, and explosive manufacture, while the experiments of the Bureau of Chemistry have shown that wool grease is one of the most effective materials for waterproofing shoe leather. Great quantities of waterproofing materials will be needed for the shoes of the American armies, and wool grease, which can not be used for food or soap making, is urgently needed for this purpose. The present supply is inadequate, and there has been an increase of 500 per cent in the price of this product. Under this project practical methods for the recovery of wool grease and of potassium carbonate will be developed and put into operation in the chief wool-scouring plants in this country.

In addition to the recovery of these important materials, now entirely wasted, the work will result in preventing the pollution of streams now occasioned by running the scouring wastes into the rivers.

*Proposed expenditures, 1918-19.—\$9,000.*

**Total, Bureau of Chemistry, \$90,000.**



## BUREAU OF BIOLOGICAL SURVEY.

### DESTRUCTION OF PRAIRIE DOGS, GOPHERS, AND GROUND SQUIRRELS.

This work supplements that carried on under the project "Destruction of Injurious Rodents," the cost of which is paid from the regular appropriations of the bureau.

It is conservatively estimated that a loss of \$150,000,000 annually, largely in cereals, is suffered from the depredations of native rodents, chiefly prairie dogs, ground squirrels, pocket gophers, and meadow and pine mice, and \$200,000,000, mostly foodstuffs, from house rats and mice. The latter amount does not include in direct losses occasioned by human diseases disseminated by rats and the necessary expenditures in combating them.

Work already accomplished in the extermination of rodents proves conclusively that an enormous saving in grain and forage crops can be effected directly and economically in this way. The work has proved so effective and has served such a definite need of farmers and stockmen that the department is receiving requests for assistance in controlling these pests from all parts of the West. Large sums are already pledged by States, counties, farm bureaus, and stockmen's associations to provide poison supplies for the cooperative campaigns planned under project agreements with State extension departments, in addition to large contributions of labor and materials which will be furnished by cooperators. So far as possible, the department will provide trained leadership for the campaigns with a view to protect adequately crops and range from the depredations of rodents coming from Government lands adjacent to the private holdings being cleared of these pests in the cooperative campaigns.

*Proposed expenditures, 1918-19.—\$100,000.*

### DESTRUCTION OF PREDATORY ANIMALS.

This work is an extension of that conducted under the project "Destruction of Predatory Animals in the National Forests and on the Public Domain."

The destructiveness of predatory animals on the western ranges results in a serious decrease of the available meat supply. The Forest Service estimates that each wolf causes an annual loss in stock amounting to \$1,000. Coyotes are much more numerous than wolves, and the aggregate of losses caused by them is enormous. The losses to sheep herds in Utah and adjacent States from the ravages of predatory animals are conservatively estimated at 500,000 head annually. In addition to the immense meat loss represented this involves the loss of about 4,000,000 pounds of wool annually. The New Mexico Agricultural College reports that predatory animals destroy annually 3 per cent of the cattle in New Mexico, amounting to a total loss each year of about 34,350 head, and also destroy about 165,000 head of sheep, with a resulting decrease of about 16,000,000 pounds of meat and 1,320,000 pounds of wool annually. The number of horses killed annually by predatory animals in New Mexico alone is estimated at 850, making a total aggregate annual loss in New Mexico from the depredations of predatory animals of \$2,715,250.

The department under its regular appropriations has destroyed a great many predatory animals, resulting in saving large numbers of live stock from destruction by wolves, coyotes, and other predatory animals. That this work is exceedingly helpful and popular with the stockmen is shown by the increased cooperation and financial support which is constantly being given the work by States and stockmen's associations.

*Proposed expenditures, 1918-19.—\$125,000.*

**Total, Bureau of Biological Survey, \$225,000.**



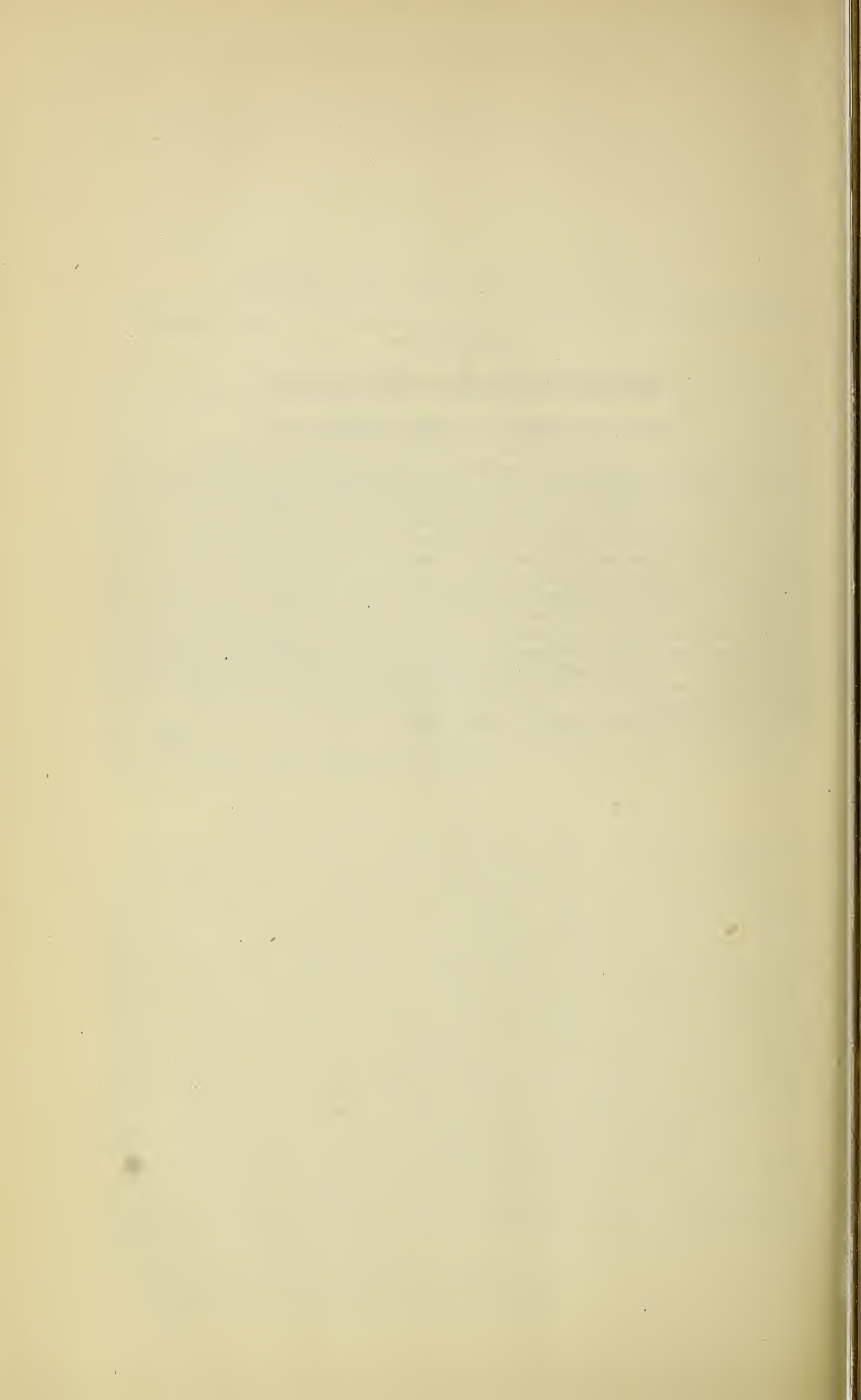
## BUREAU OF CROP ESTIMATES.

### SPECIAL WORK IN CROP ESTIMATING.

The demand for estimates of crop and live-stock production, supplies of food and feed, and other factors relating to the present and future food supply has been constant and insistent since the beginning of the European war. With the funds made available by the food production act the Bureau of Crop Estimates will be able to increase its facilities for the rapid handling of special inquiries and for preparing reports on acreage, production, stocks, storage capacity, etc., by counties, instead of on a State basis as heretofore. It will also be possible to extend the service to include crops not hitherto included in the reports of the bureau. The work of making surveys of food stocks on farms will be continued, and the Bureau of Markets, Food Administration, Grain Corporation, and other Government agencies will be furnished such special information as may be needed from time to time. Weekly and semimonthly reports on truck crops will be issued based upon special telegraphic reports made to the bureau.

*Proposed expenditures, 1918-19.—\$234,540.*







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(Prepared under the direction of C. H. Greathouse, Division of Publications.)

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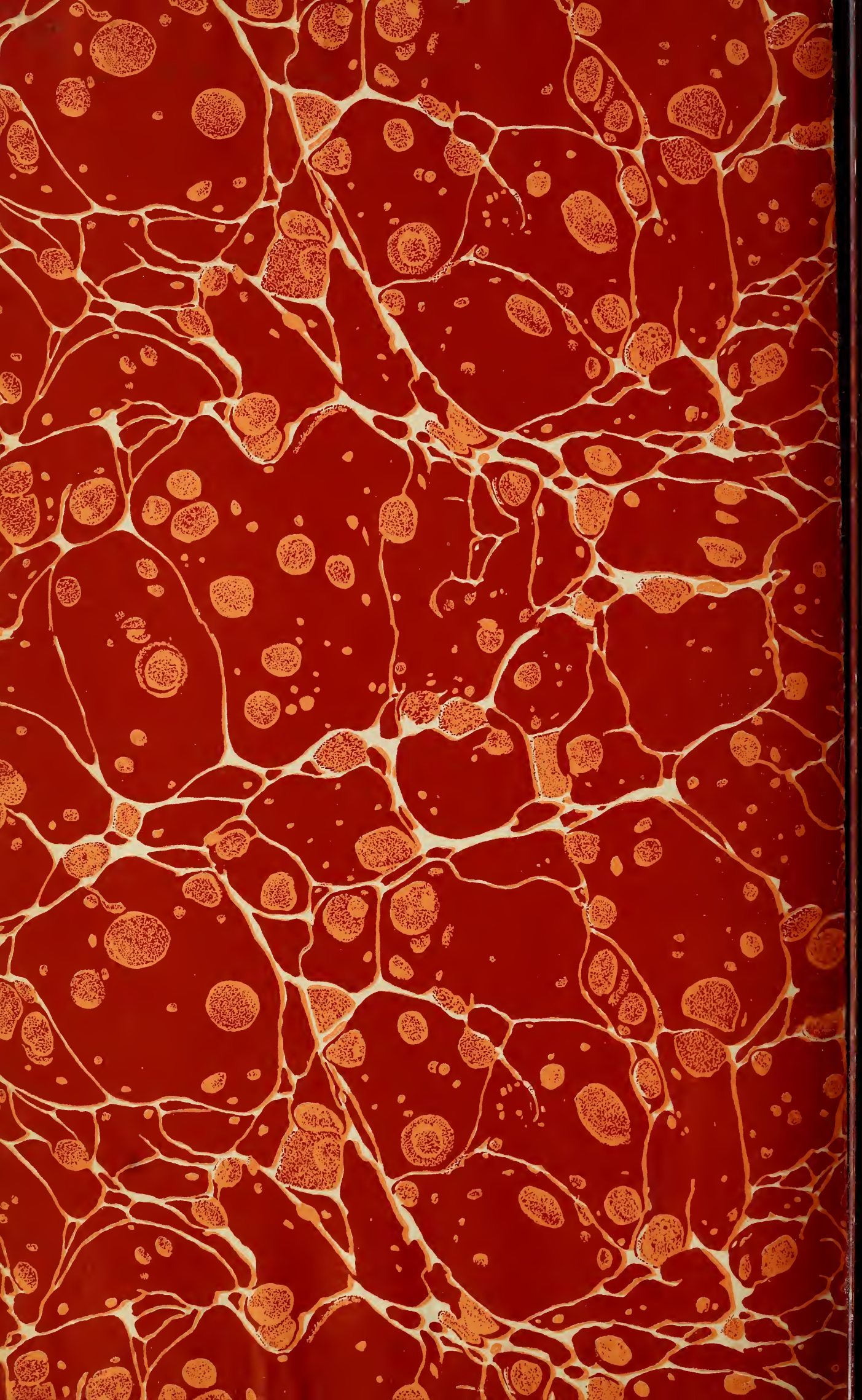
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